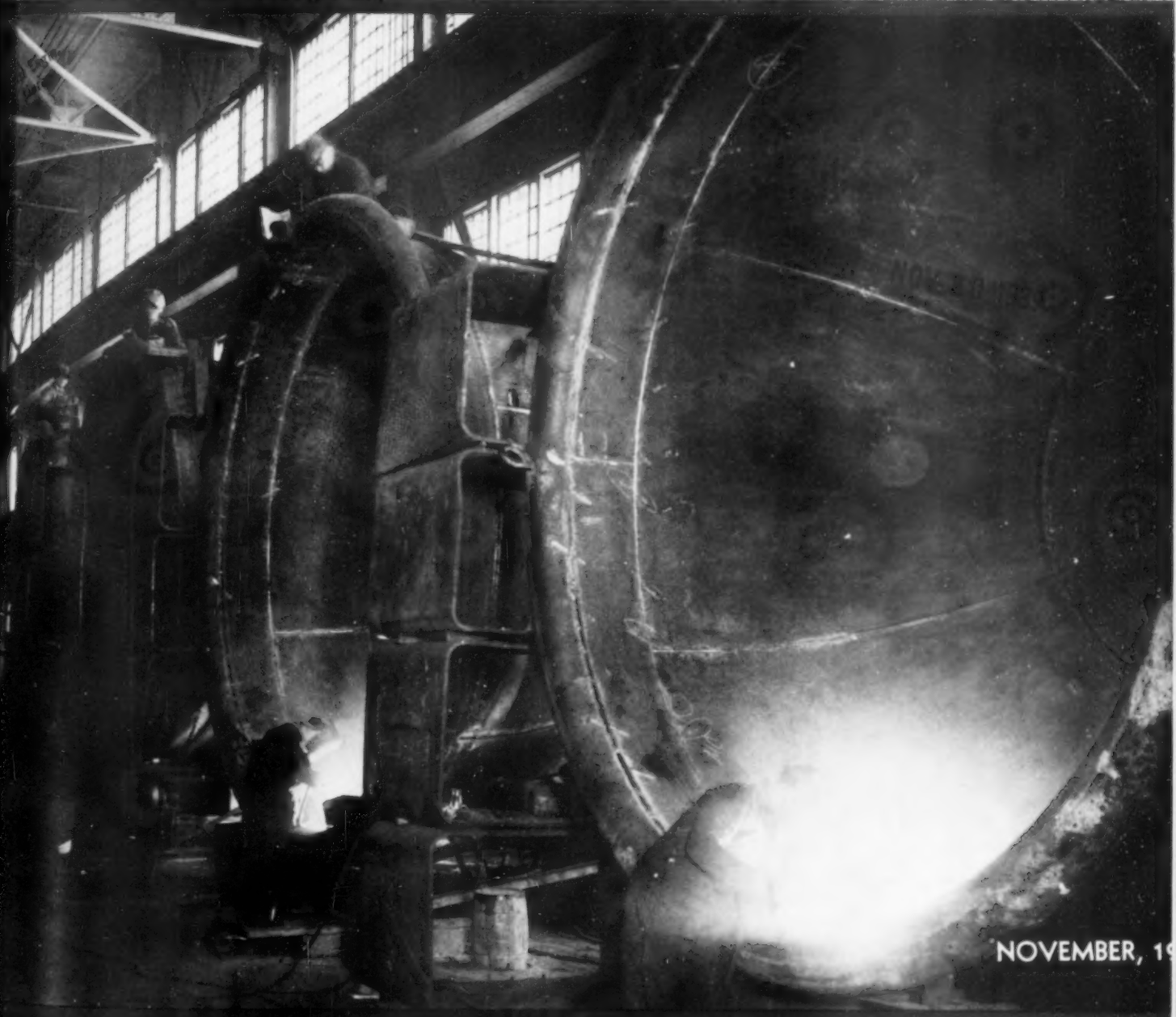
The Welding Journal



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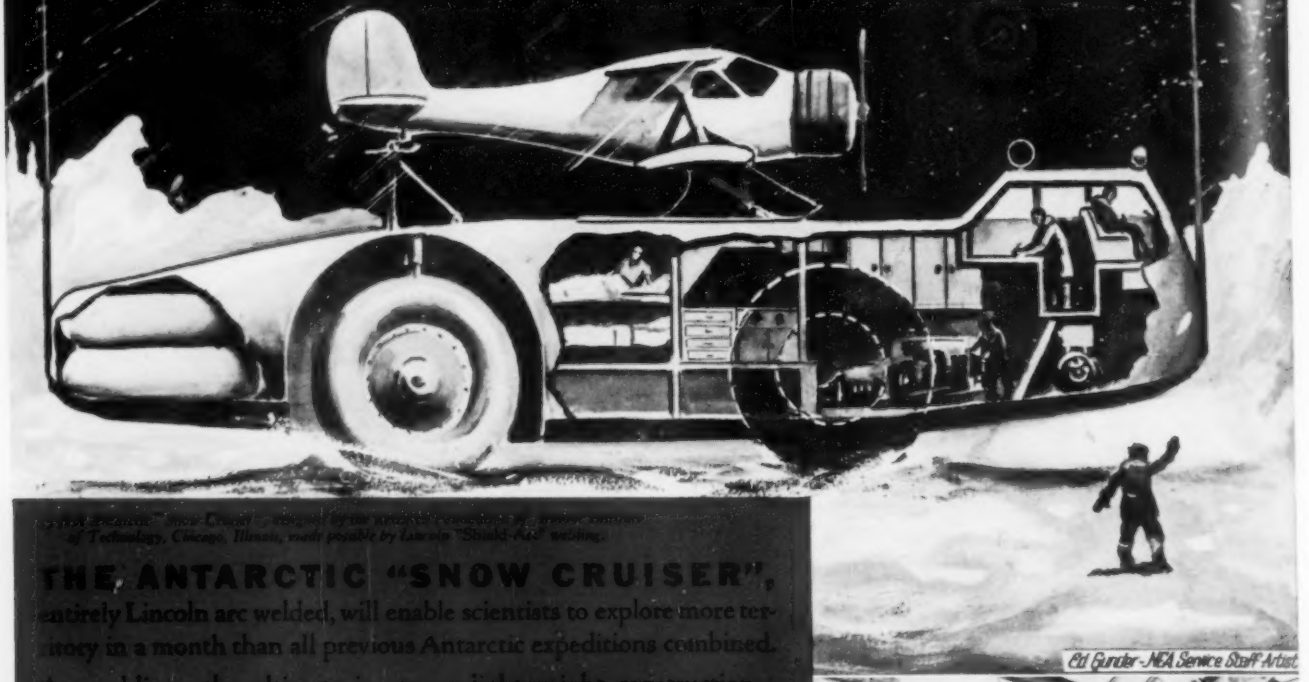
ANOTHER ACHIEVEMENT OF SCIENCE AND ENGINEERING MADE POSSIBLE BY LINCOLN ARC WELDING



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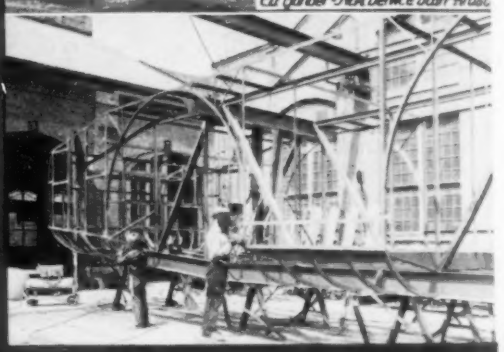

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Published for the Advancement of the Science and Art of Welding

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Welded Steel Kettles 1⅛ inch thick, 13 foot diameter. Hemispherical Bottoms and Rolled Edges. *Courtesy Blaw-Knox Company.*

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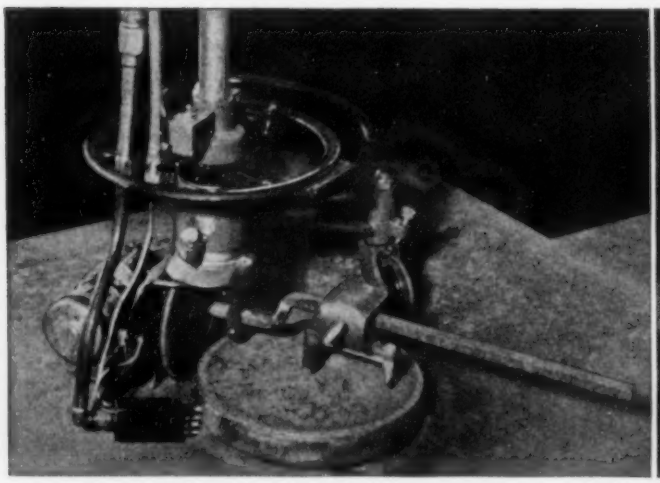
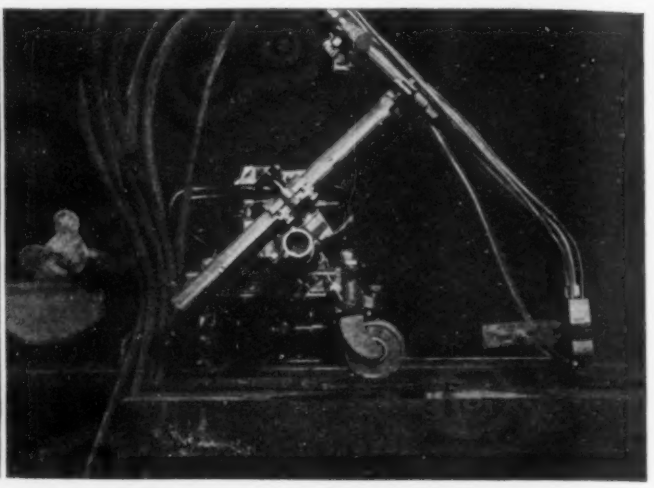
Ways to Make Money

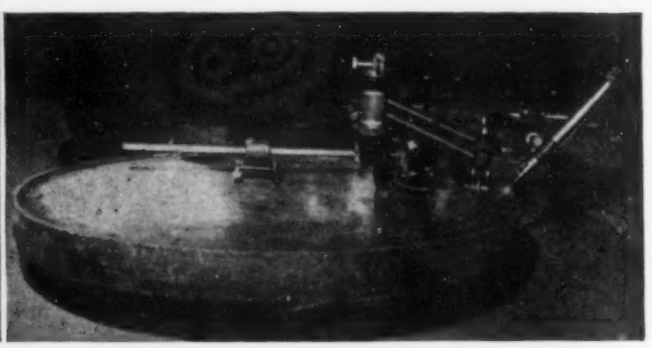
with the CM-16 Portable Oxweld Oxy-Acetylene Cutting Machine





The CM-16 is easily adaptable to flame-hardening and flame-softening. A flame-cut gear blank (left) is being softened to make machining easier. The flame-hardening setup (right) is used to harden machine parts so they will last longer.

Storage tank heads, sheets, and bottoms can be economically cut with the CM-16. This large steel plate is being shaped for a tank bottom.



Here the CM-16, equipped with heavy cutting attachment, is beveling the edge of a head for a gas storage tank preparatory to welding.

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Welding Journal

VOLUME 18, No. 11 NOVEMBER 1939

THE USE AND APPLICATION OF Portable Spot Welding*

By C. E. HEITMAN†

ONE of the first large-scale commercial applications of the resistance welding process was to the fabrication of steel automobile bodies. The welding equipment took the form of stationary upright machines, making it necessary to transport the parts to be welded to the machine. As improvements in design took place and as larger presses made possible the forming of large stampings, it became increasingly difficult to move the work pieces to the machine. In fact, these improvements in product design and in press shop equipment demanded improvements in the welding equipment, if that process was to remain an economical tool of fabrication.

In answer to this challenge a machine was devised and built, which could be transported to the work pieces. Thus was born, of necessity, the first portable spot-welding machine.

Naturally quite crude in its early stages of development, this method of resistance welding, through further development and refinement on the part of both the user and the equipment manufacturer, has in many cases made possible the economic application of resistance welding which would otherwise have been impossible, and in other cases has increased the economies over the previous method.

In its present form a portable spot-welding unit consists of a portable welding gun, by means of which pressure is applied to the parts being welded, a welding transformer which may be stationary or movable, and which is electrically connected to the welding gun by means of flexible welding cables, and means for applying and timing the electric current to the transformer. This arrangement presents many disadvantages over the stationary welding machine.

Although considerable ingenuity has been exercised in the design and construction of welding guns, they are usually quite heavy and cumbersome to manipulate. In any attempt to further reduce the weight and size of the gun we must resist the great temptation to reduce the electrode pressure which in most cases is already at the very minimum permissible for satisfactory welding.

The welding cables provide another serious disadvantage to portable spot welding. These cables must be sufficiently flexible for easy handling of the welding gun and yet must conduct the 10,000 to 15,000 amperes necessary for the average automobile body welding. On high-speed operations these cables are water cooled to prevent overheating, yet cable failures occur all too frequently causing a serious maintenance item.

As compared to an equivalent stationary welding machine, the portable welding transformer is several times larger, due to the fact that it must provide the losses encountered in the welding cables. Likewise the control equipment, the supply lines and the power equipment must be correspondingly larger.

These are some of the major disadvantages of portable spot welding. Without going into great detail, I mention them to emphasize the point that this method of spot welding is far from ideal, but born of necessity. It is a process which fills a need in industry, and although many of its applications are destined to be replaced by

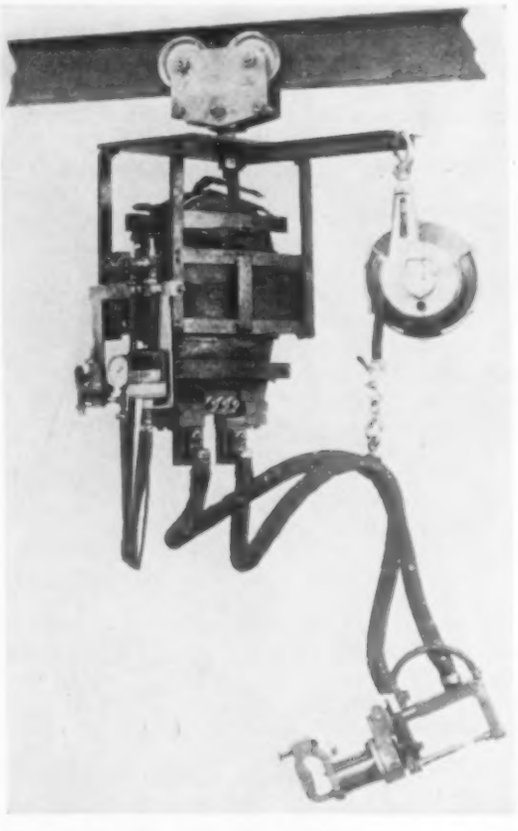

Fig. 1—Showing Portable Spot Welding Unit Commonly Used for Production Line Welding

* Presented at the Annual Meeting, American Welding Society, Chicago, October 23 to 27, 1939.

† Chief Electrical Engineer, Edward G. Budd Manufacturing Co., Philadelphia, Pa.

Fig. 2—Portable Welding Tool Shown in Operation on Rail Car Side Frame

automatic multi-spot-welding machines, it will continue to serve economically in many applications.

In further-discussing portable spot welding, I should like to divide it into two classes:

1. As applied to production line fabrication where the unit is semi-portable, in that it forms a permanent part of that particular production line and is portable only in the sense that it is movable through a relatively short distance.

2. As applied to job shop fabrication wherein the quantity production of any one part does not justify a production line, and where one piece of equipment may see duty on many jobs in different parts of the shop in any one working day.

As applied to production line fabrication a given piece of equipment performs the same operation day after day, welding in the same locations on the same product as it passes along a conveyor. Since the welding conditions seldom change throughout one production run, all attention may be concentrated on one particular condition and the machine adjusted accordingly. The operator then has the job of guiding the tool and operating the control button.

For this application a typical portable spot-welding equipment is as shown in Fig. 1. This photograph shows the welding transformer, welding cables and portable gun all supported as a unit from a monorail. In addition the welding gun is supported by means of a balancer and is thus free to move up and down with respect to the transformer. The welding contactor and timer are located on the structure overhead, and the electrical connections to the transformer are by means of flexible cables which allows the transformer to be moved longitudinally through a distance of 15 to 20 feet.

Many of these portable spot-welding applications are such as to be very easily adaptable to automatic welding operations. On production schedules such as are often found in the automotive industry it has been found that such applications are no longer economical, and in numerous cases automatic milti-spot-welding machines have already replaced the portable welding method by increased speeds and lower costs. The prospects are that more and more such replacements on high production jobs will take place in the very near future, leaving for portable welding only those jobs which cannot justify the relatively high initial cost of an automatic machine. The applications of portable spot welding in the automotive industry are therefore on the decline.

It is in the second classification mentioned above, namely, the job shop, that portable spot welding has its greatest future. The very name "job shop" implies comparatively low production for any one design, where the cost of automatic machines can usually not be justified. It is in this field that portable spot welding is particularly applicable. Every equipment must, and can very easily be somewhat of a general purpose machine. It is portable, as the name implies, and can be used on many different jobs in any part of the shop. It is this application that I should like to discuss in some detail.

This method finds widespread application in our shops, in the fabrication of railway cars and equipment as well as in the construction of numerous products of stainless as well as mild steel for many unallied industries. The equipment is the same in all shops, and may be used at one time in building a railway car and at another time in the construction of a tank for the chemical industry or a stainless steel structure for the U. S. Navy. For this reason, I believe that the following discussion would apply equally well to all sheet metal job shops.

GENERAL PURPOSE PORTABLE "SHOTWELD" MACHINE

A complete "Shotweld" machine as used in our stainless steel fabricating shops consists of:

1. An air or hydraulically operated welding tool.
2. A welding transformer.
3. A welding timer, which serves to control as well as time the flow of welding current.
4. A weld recorder—a device for recording and indicating the consistency of welding current and time.

None of these four component parts can be considered as portable in the sense that a screwdriver is portable, yet each one can be moved from one part of the shop to another with comparative ease.

The gages of metal to be welded vary from a minimum of two thicknesses of 0.004 inch to two thicknesses of $^3/_{16}$ inch. It is obviously impractical to cover this entire range of welding with one size of welding equipment, due to the wide range of welding currents necessary. Experience has shown that five different sizes of equipment, namely, 10, 25, 50, 100 and 200 kva., give the best economic balance, although on certain special jobs larger units are used wherein the equipment remains stationary. Naturally the size and weight of the various items of equipment vary with the capacity of the unit, and the gage of metal to be welded dictates the size of unit to be used. The welding tools in common use vary from a small tool weighing 15 pounds and developing 200 pounds electrode pressure to a tool weighing 300 pounds and developing 8000 pounds electrode pressure, with many other intermediate sizes and designs. All are considered portable in that they are carried to the job, although of course it is necessary to support the larger ones by means of some balancing arrangement as shown in Fig. 2.

This photograph shows a welding tool which develops

1600 pounds electrode pressure welding together two 0.060-inch thick pieces of high tensile stainless steel on a Rail Car Side Frame. The tool is being operated from a 100 kva. "Shotweld" machine.

Items 2, 3 and 4 of the welding equipment vary in size from the small 10 kva. unit (Fig. 3) with timer recorder and transformer in one case to the 200 kva. unit (Fig. 4) with recorder and transformer in one case and the timer in another. This equipment is provided with wheels for portability although the present tendency is toward placing the timers in semi-permanent positions and moving the interchangeable welding transformer units according to the dictates of the shop schedule.

WELDING TOOLS

On most sub-assembly operations where the work pieces can be moved to the machine, the pedestal type welding tool finds its application. It is common practice to use portable tools, supported by counterbalancing arrangements, to spot-tack the pieces together in a jig, and then complete the welding of the tacked assembly on a pedestal type stationary tool.

The advantages of the pedestal type tool over the portable type are many.

1. The welding leads can usually be made shorter and heavier, resulting in the use of smaller transformer for any required welding current.
2. It permits better alignment of the work piece and the welding electrodes.
3. More efficient water cooling can be obtained.
4. Higher welding speeds are obtained.

It is for these reasons that the various assemblies are broken down into smaller assemblies and welded on the stationary machines. In these operations even the smaller portable tools are often found clamped to a work bench, and operated as a stationary tool.

In the assembly of these various smaller sub-assemblies, into larger sub-assemblies the so-called semi-portable welding is employed. In such operations the welding transformer is supported on a monorail or rolled on wheels along a track on the floor, and the welding tool is supported by a trolley and balancer having sufficient range to cover the entire part to be welded. A large assembly jig, such as used in assembling a rail car side frame, may have several such units working simultaneously.

It is in the final or main assembly jig, however, that the real portable welding finds its application. In these operations it is often impossible to provide counterbalancers for the tools. It is left to the operator, therefore, to manipulate the welding tool as he would operate a wrench or portable drill. It is often a quite unhandy and difficult operation, but has proven to be more economical than the other conventional methods of fabrication.

Figure 5 shows an operator manipulating one of the intermediate size welding tools on a final assembly operation on one of our stainless steel rail car structures. These assembly operations are inherently of comparatively low welding speed so that water cooling is usually not necessary.

Due to the difficulty in handling the larger tools, such operations are held to a minimum and the thickness of the parts to be welded held as small as possible.

TIMING EQUIPMENT

With the exception of some of the earlier units, the welding timers are of the electronic type wherein the primary welding current is timed and interrupted by means of vaccum tubes. The 10 kva. unit shown in Fig. 3 is representative of these earlier units which time and interrupt the primary current by means of a synchronously driven mechanical switch. These mechanical timing units have proven entirely satisfactory, but the superior ability of the electronic units in interrupting the high peak currents has made them more desirable. The present trend is toward electronic control for all sizes of units.

In a number of cases, the duty cycle to which this equipment is subjected is quite low, due to the nature of the work, so that the full capacity of the electronic

Fig. 3—10 Kva. Portable "Shotweld" Machine Complete with Timer Recorder and Welding Transformer

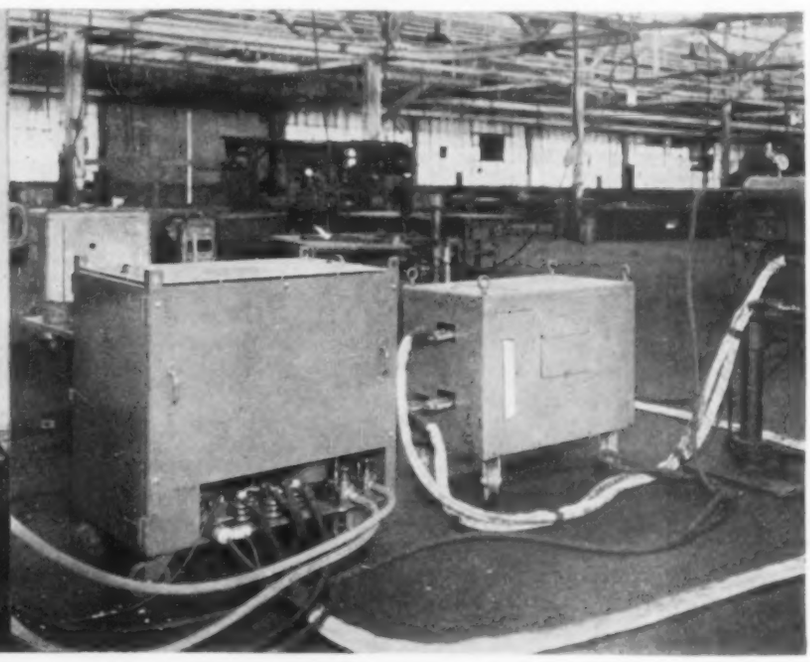

Fig. 4—200 Kva. Portable "Shotweld" Machine Showing Timer to the Left and Welding Unit with Transformer and Weld Recorder to the Right

timing unit is not realized. In order, therefore, to make a welding timer do more work, a scheme was devised whereby one timer controls three welding transformers, through interlocks such as to permit operation of only one transformer at any one time. This device we call a "triple control" and has proven entirely satisfactory and economical on low production work. It is, of course, possible to control even more than three welding units from one timer, although as the number increases, the interlocking system becomes more complicated and the scheme loses some of its economic advantages.

In that portion of the shop devoted to the assembly operations of comparatively low welding speeds, a multiplicity of the triple control systems are used. The welding timers are semi-permanently located throughout the shop and a triple control outlet located at each column. The welding units are then moved from one part of the shop to another and connected to the most convenient outlet.

WELDING TECHNIQUE

It has been found that the best welding results on stainless steel have been obtained with electrode pressures ranging from 30,000 to 35,000 pounds per square inch based on resulting weld area. This is about two to three times that recommended for mild steel welding, and is no doubt brought about partially by the greater hardness and stiffness of the stainless steel material. Due to the higher electrical resistivity of stainless steel, however, the required welding currents are lower than those required for corresponding gages of mild steel.

A chart showing the required weld shear strength, electrode pressure, electrode diameter and welding time is issued to the shop and all welding tests are made in strict accordance with this chart. The equipment is set up in accordance with the recommended electrode diameter, pressure and welding time, and the welding current is adjusted to produce the required weld shear strength. Test welds are made in this manner for each different set-up, and the welds are tested to destruction in a tension testing machine to insure that they meet the required strength. A similar shear strength chart is issued to the design engineering department with shear values 15% less than those given to the shop. This allows the shop a 15% margin which is at all times held under control by means of the weld recorder, described below.

THE WELD RECORDER

On some of the earlier equipments the weld recorder is mounted on the welding transformer, receiving its recorded impulse, which is proportional to I^2t, directly from the secondary circuit of the welding transformer, through a suitable current transformer. In the more recent equipments, however, the recorder is actuated from the primary welding current and can therefore be mounted permanently at the column, leaving the welding transformer free from this physical incumbrance. This is permissible because of the fact that the electronic timing control eliminates the primary transient current and thus assures that the primary current is always proportional to the secondary or welding current for a given ratio of transformation. This system relieves the welding transformer of some of its physical burden and makes it more portable, while exercising the same supervisory control over the consistency of welding.

The weld recorder is a device for indicating and recording the consistency of welding current and time for repetitive welds. Its indication is directly proportional

Fig. 5—Portable Welding Tool Shown in Operation on Rail Car Final Assembly Operation

to the square of the welding current and to the first power of the welding time—that is, I^2t. As stated before, the energy which actuates this device is at all times proportional to the welding current and time, so that any variations in either of these two quantities will be immediately indicated by the recorder.

In practice, the device is adjusted to give an arbitrary mean deflection after a satisfactory test weld has been made and tested to destruction. If, therefore, the same welding current and time as were used for the test weld, are maintained for successive welds, the deflection of the instrument will vary accordingly and will operate to sound an alarm and automatically stop the machine until the operator has made compensating adjustments.

This device was developed by our company several years ago to be used as a check on the rather inconsistent timing devices available at that time, as well as to check the variations in welding current due to loose connections, variations in line voltages, etc. With the advent of modern timing and control devices, the necessity of checking the timing consistency may seem to be relatively unimportant, yet even with this modern equipment, it has been found that every once in a while the timing will vary. This may be through no fault of the equipment itself, yet it does happen, and indicates the necessity for some supervisory device, if consistent welding is to be maintained.

Another, and even greater cause of inconsistent welding is the variation in supply voltage. Not so much the hour to hour variation, but the second to second variation caused by other welding equipment drawing power from a common supply line. It is not uncommon to find that one welding machine may cause the line voltage to drop as much as 20% during the time the weld is being made. If, therefore, another welding machine, supplied from this feeder line, should happen to weld at the same time, its welding current would be 20% less than normal, and the welding heat 36% less than normal.

In a shop employing many welding machines, it is a

difficult and expensive project to design and construct feeder lines and power equipment of such capacity as to prevent these undue voltage variations. It is the purpose of the weld recorder to detect such variations and to warn the operator and supervisor that compensating measures must be taken.

In practice the recorder limits are set at plus or minus 10% from the shop shear strength chart. This insures that the welds made on any structure have a shear strength above that used by the designer, which is 15% below the shop value.

WELDING TRANSFORMERS

This item of equipment is one which causes little or no trouble in the shop. Care must be exercised in specifying the proper open circuit secondary voltage for delivering the required secondary current to the relatively high impedance of the welding cables, and sufficient transformer capacity must be obtained in order to prevent overheating of the unit. These units are obtained from the regular welding transformer manufacturers and with proper mechanical protection, depending on the shop operating conditions, they are relatively trouble-free.

WELDING POWER SUPPLY

Because of the supervisory control exercised by the weld recorder, the danger of undue line voltage variations is not as serious as it would otherwise be. Yet it would be quite disrupting to a shop if the weld recorder indicated an undercurrent weld, and locked out the machine, with any degree of regularity. It has been found, therefore, that engineering judgment and discretion must be used in laying out the shop's feeder lines with sufficient capacity to prevent these undue voltage variations under normal operating conditions. The weld recorder then takes care of the abnormal operating conditions, which if allowed to dictate the feeder line layout would make this one item almost prohibitively expensive.

The details of the feeder line system are beyond the scope of this paper. In general, however, the design of the power supply system is based entirely on voltage drop. The relatively low duty cycle and load factor of the equipment make the consideration of line heating one of lesser importance. In other words, when the power supply system is designed to meet the requirements of voltage drop, the capacity of the system from a heating standpoint is more than ample.

Everyone familiar with resistance welding is likewise familiar with the many objections to portable spot welding. It is still the source of many troubles, but if the process receives as much development in the next five years as it has in the past five, these troubles will be reduced many-fold. Everyone will agree that stationary welding is preferable, yet portable spot welding has won and will continue to win still more products, which would otherwise have been uneconomical to resistance weld.

Statement of the Ownership, Management, Circulation, etc.

REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

OF THE WELDING JOURNAL, published monthly at Easton, Pa., for October 1, 1939.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared William Spraragen, who, having been duly sworn according to law, deposes and says that he is the Editor of THE WELDING JOURNAL and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)
None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

W. SPRARAGEN, Editor.

Sworn to and subscribed before me this 21st day of September, 1939.
(Seal) MARY T. HICKEY
Notary Public, New York County Clerk's No. 134.
New York County Register's No. 0-H-133.
(My commission expires March 30, 1940.)

WELDED CABLE SADDLES of Tacoma Narrows Bridge*

By JONATHAN JONES†

IT IS believed that the cable saddles of the Tacoma Narrows Bridge represent the first departure in the United States from the use of steel castings, and the first use of welded structural plate, for these heavy and rather complicated pieces.

This is a highway bridge of 2800 ft. span, carrying a 24 inch wide reinforced concrete roadway slab, and it requires two parallel-wire cables of 17 inch diameter each. The vertical reaction of each cable upon its saddle, from dead and live loads, is 10,800,000 lb. Each cable is to be spun in 19 strands, and each strand will be spun outside the saddle and transferred into it when completed. As on the Golden Gate Bridge, a cross section of the cable before compacting will show the 19 strands in a hexagon with its apices up and down. The hexagon will, however, not be quite regular, as measures will be taken to so place the strands that the compacting into a circle will require less displacement of wires than in the case of a true hexagon. This feature accounts for the novel shape of the cable trough, in the saddle, as shown in the cross section Fig. 2.

One of the major problems in the saddle design was the transfer of each cable load to all principal elements of its tower leg. The tower legs are cruciform, four square steel shafts being assembled to form a cross of five cell spaces, as shown in Fig. 1. The width over the tower web plates, transversely of the bridge is 13 ft. $1^1/_2$ inches (originally 11 ft. $7^1/_2$ inches of which 3 ft. 6 inches is the width of the central cell.

At one stage it was proposed to make the saddle a casting $3^1/_2$ ft. in width, or as wide as the central cell, and to load the remainder of the column top by means of a transverse grillage. This grillage, however, was difficult to design in any reasonable depth, since its deformation would defeat the purpose of fully loading the outermost column webs. A saddle with ribs extending out 5 ft. 10 inches to each side proved too deep and heavy to be practical.

A compromise was adopted, whereby the saddle width was made 10 ft., leaving part of the two lateral column cells not covered. Deep diaphragms built into these cells, at the extremities of the saddle, served to distribute satisfactorily over the remainder of the column material.

This determined a saddle cruciform in plan, 10 ft. wide over the central third of its length and 4 ft. 2 inches wide fore and aft. The 10 ft. width necessitated a depth of slightly over 3 ft. from bottom of cable trough to under side of saddle. The saddle length of 13 ft. $9^1/_2$ inches conformed to the tower design and gave a satisfactory bearing pressure for the cable wire in the saddle trough.

At this stage the decision was made, without making comparative cost estimates, to weld these saddles instead of casting them. There were several valid reasons. The metal is of radically varying thicknesses, which on other bridges has made for difficulties in securing sound castings. The pattern is very costly. The amount of money tied up in the chance of losing a casting through mishaps is very large. The time element seemed to favor the weldment. And finally, if one casting should be rejected, the time required to replace it would wreck the schedule for completion of the bridge.

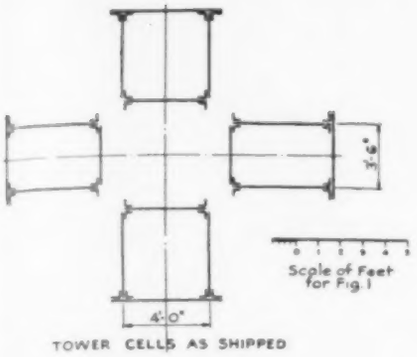
Another factor would have interfered with the use of castings, but could be overcome in the case of weldments, namely the machining of the cable trough. It has been customary to set the castings on a side in a boring mill and sweep them on a circular arc past a fixed tool stand. At the time this bridge was fabricated there was no boring mill known to be available that had sufficient height to accommodate these 10 ft. wide pieces in the up-ended position. This fact not only eliminated castings of the adopted cruciform shape, but it had a major influence on the welding procedure, as given hereafter.

In the cross section, Fig. 2, the elevation, Fig. 3, and the plan, Fig. 4, all details and all dimensions have been eliminated except those defining the main elements of the piece and the main welds. All covers, gaskets, end hoods, beacon supports and hand-rope attachments, have been eliminated as not pertinent to the present description. The sequence of manufacture was as follows:

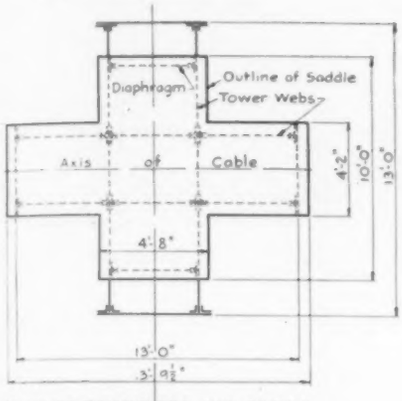
1. The cable trough rolled slab 8 inches thick was curved at a low red heat to the 16 ft. radius under a 7000 ton hydraulic bending press.
2. The 2-inch vertical stem piece was machine flame cut at its upper edge both for radius and for double-vee bevel, the depth being over size.
3. The stem was welded to the underside of the trough slab (weld A) with a full reinforced butt weld.
4. The T-section thus formed was rough-machined for the slab sides and the cable trough. For this operation, the four T's were upended so that the trough and the stem piece lay in a horizontal plane, and were mounted inside the track of a floor-type boring and facing mill ordinarily used for machining tunnel lining segments. A tool carriage traveling 360 degrees on the circular track then cut the external circular work on the four trough slabs.
5. The T-sections were then stress-relieved. The maximum change of dimension found to result from this treatment was $^1/_{16}$ inch. This was the only stress relief given to any part of these saddles. For weldments of such size a final stress relief would seem to some designers to be advisable; stress relieving would however have carried with it as a corollary, a final machining to accurate dimensions, and this, for the reason stated above could not be accomplished on any available equipment. It is, however, believed to be the consensus of opinion that for the nature of service to be performed by these saddles, a general stress relief is not important. What

* To be presented at Joint Meeting, New York Sections, A. W. S. and A. S. C. E., Dec. 20, 1939.

† Chief Engineer, Fabricated Steel Construction Division, Bethlehem Steel Company.

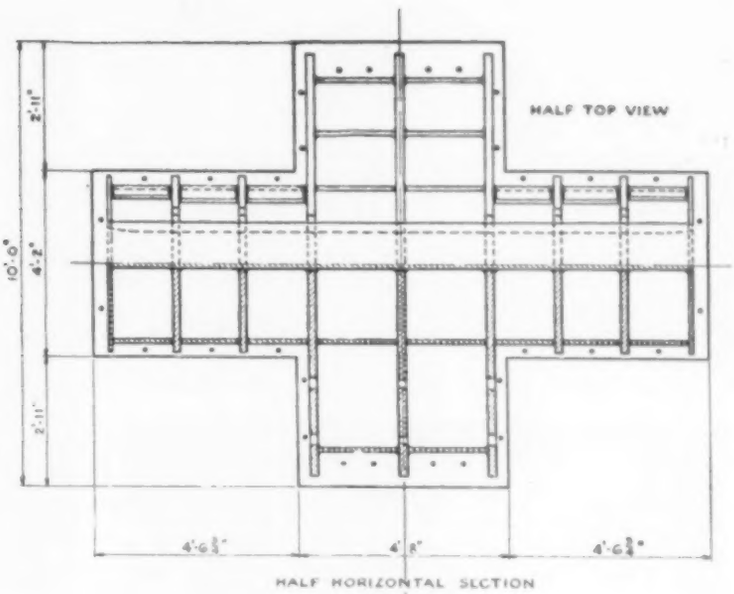


TOWER CELLS AS SHIPPED



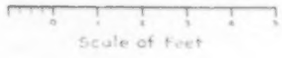
PLAN OF TOWER TOP AND SADDLE

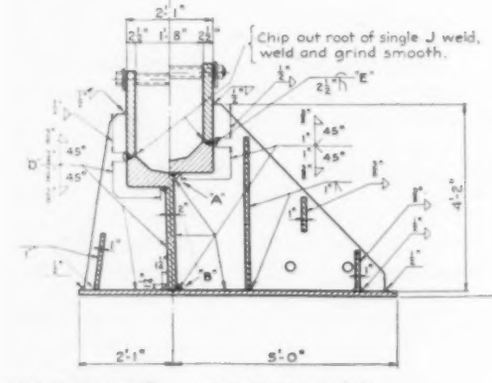
FIG. 1



HALF HORIZONTAL SECTION

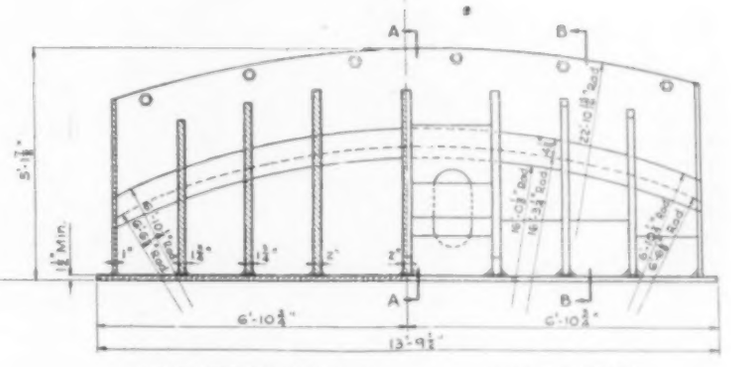
FIG. 4





HALF SECTION B-B HALF SECTION A-A

FIG. 2



HALF VERTICAL SECTION HALF ELEVATION

FIG. 3

is important, is that the dimensions of the trough, once established, be not greatly warped by subsequent welding.

6. The T-sections were taken back to the boring mill and given their final machining. This was somewhat exacting, as at each end of the circular arc there are run-off curves of shorter radius, not shown in Fig. 3, producing a flare in the horizontal as well as the vertical plane. This final machining included the grooves for the side welds E.

7. The bottom edge of the stem piece was machine flame-cut and double-vee beveled for the full butt weld to the base plate (weld B).

8. The $1^1/_2$-inch base plate (10 ft. x 13 ft. $9^1/_2$ inches) was ordered 2 inches thick to allow $^1/_2$ inch for a final bottom cut. This also permitted waste from base plate to be used for some of the 2 inch thick bracket plates. The base plate was furnished flattened at the mill and was not premachined before assembly. This plate was solidly bolted down to a 10 ft. x 15 ft. x $9^1/_2$ inches cast steel surface plate weighing about 44,000 lb. which in turn was mounted on a trunnion device for positioning the welding.

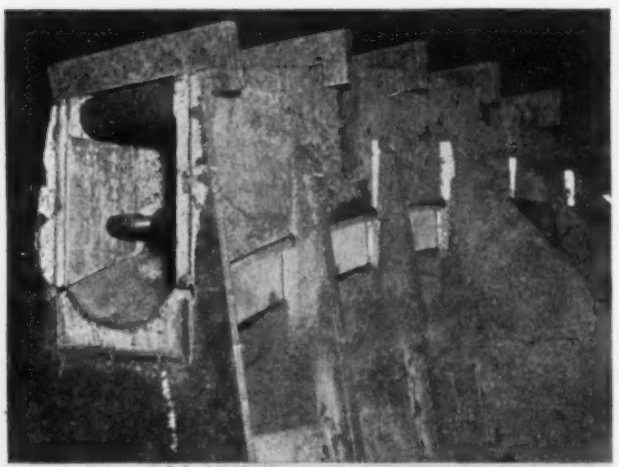
9. The preassembled T of cable groove and stem piece was mounted on the base plate and tacked. All transverse bracket plates, 9 on each side, were flame-tailored to fit around the T in the right relationship, and with the proper groove, for welds D; also along the base slab. These were, it will be noted, full tee butt welds with reinforcement. In the case of the wider brackets reaching out to the 10 ft. width, horizontal shear is developed between bracket and base of an intensity requiring this full butt weld; for the narrower brackets the computations indicated that fillets would suffice but butts were used to keep all joints of the highest standard. At this stage of erection the vertical $2^1/_2$ inch side plates enclosing the trough were not placed; the uppermost part of the bracket plates was purposely shaped to extend

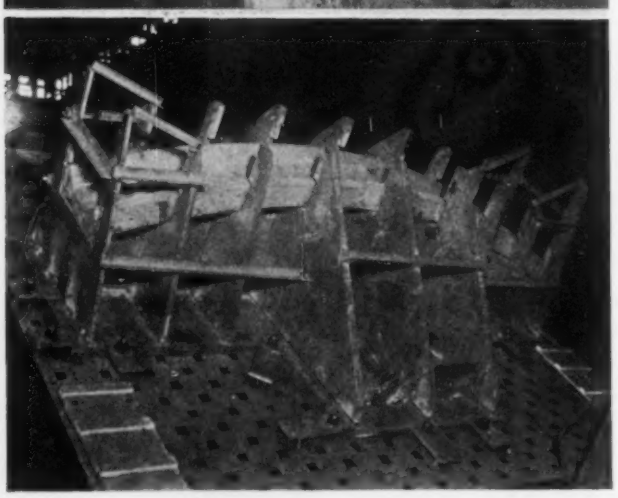
somewhat into the space which these side plates would later occupy.

10. Welding was now commenced at the bottom and brought up toward the trough, to minimize shrinkage pulls on the latter. Welds were positioned, and flat position, high-heat electrodes used. Most of the heavy welds were made in step-back sequence, the full number of passes being built up in short lengths with intervening gaps for later closure. The resulting assembly showed no distortion of the machined cable groove.

11. A cutting torch on a track now cut the upper ends of the side bracket plates to the exact vertical plane of the outside face of the $2^1/_2$-inch vertical side plates.

Close-Up Showing Welding Grooves for Trough Side Plates

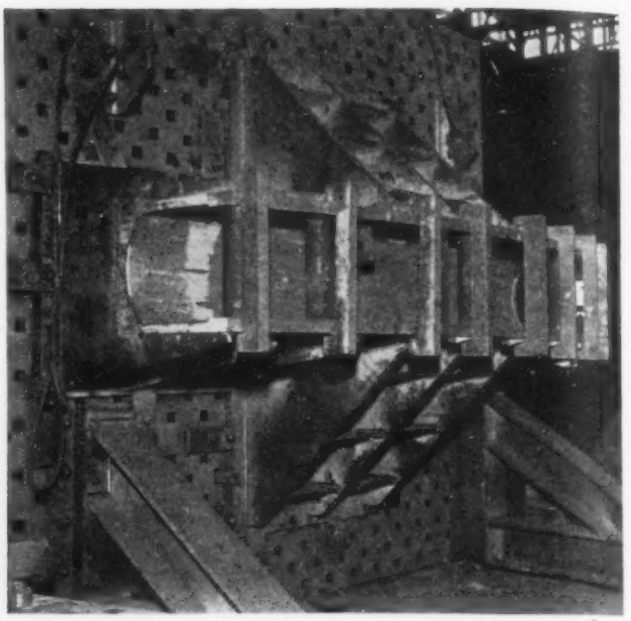




Saddle Fitted Up for Welding of Ribs, Trough Slab and Base Plate

12. The side plates were then tacked in place and welded. They were heavily braced across, and were also supported by the tops of the side brackets. Because this was a $2^1/_2$-inch unsymmetrical weld (weld E), it was the one considered most apt to produce unmanageable warpage; the maximum variation across the tops of the side plates was, however, the negligible amount of $^1/_8$ inch. The cover plate, not shown in the figures, was tap-screwed in place without difficulty from this warpage.

13. The final assembly operation was to insert between the transverse bracket plates, the longitudinal stiffening plates, and to connect them with fillet welds. These end fillets, being of 1-inch leg, exerted considerable pull; and at the top of the wide brackets they pulled the latter in very slightly, this being the only spot in the entire assemblage where any warpage is observable by the naked eye.



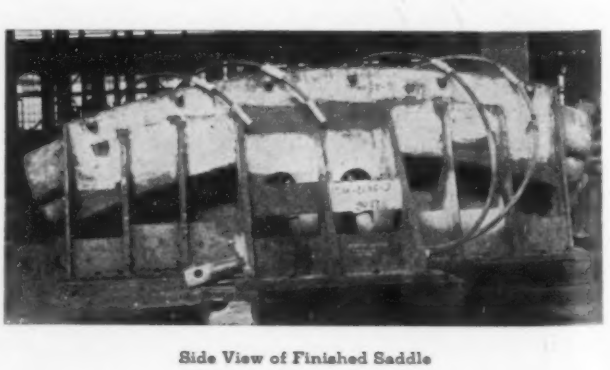
Saddle Positioned for Down Welding of Trough Side Plates

14. The warpage of the bottom of the base slab was much less than had been allowed for, and a $^3/_{16}$-inch cut brought all into a plane. The extra $^5/_{16}$ inch of height is negligible on top of a 450 ft. tower.

The width of 10 ft. interfered somewhat with the intended positions of the temporary footwalk ropes for cable construction. These were therefore threaded through holes in the side brackets, and coupling sockets cast in place before the saddles were shipped. These appear in the photograph, but not in the figures presented herewith.

The design of these saddles was worked out by close cooperation between the Washington Toll Bridge Authority through Mr. Clark H. Eldridge, its Bridge Engineer, and the engineering and manufacturing departments of Bethlehem Steel Company. For structures such as these there cannot be a design until there is a determinate manufacturing practice and welding sequence; these were mutually adjusted to give an entirely satisfactory product.

These saddles were made in the Welded Products Shop of Bethlehem Steel Company at Bethlehem, Penna. The finished weldments weighed 15 tons each as shipped. The first pair were shipped in three months after the general principles of the design and process were established firmly enough to order the rolled material from the mill.



Side View of Finished Saddle

The SELECTION and APPLICATION of High-Temperature Piping Material*

By E. H. KRIEG† and G. SONDERMAN†

IN THE years just preceding and immediately following 1920, power plants were designed for steam conditions of 250 pounds and 600° F. requiring $1^1/_2$ lb. of coal to produce 1 kwh. These limits were defined largely by the lack of suitable metals for boilers, turbines and piping. The work that the metallurgists did in the next decade enabled us to attain 1250 lb. pressure and 750° temperature just prior to 1930 or 1 lb. of coal per kwh. Then the metallurgists really got busy. Their work, coupled with the splendid progress that was made by those who were developing the intricate art of welding, finally enabled us to go to the extremely desirable conditions of 1250 lb., 950° in 1937. Even now a station is being designed for 2500 lb. boiler pressure with 950° at the turbine throttle. Right at the beginning of this paper we want to express appreciation to the American Society for Metals and the AMERICAN WELDING SOCIETY for their contributions to the progress that has been made in those fields which has enabled the engineers concerned with the design of power plants to attain performance efficiencies that would never have been possible otherwise. But at the same time, we want to bring to the attention of the metallurgical and welding societies the realization of their share of the responsibility for *future* progress in the production of power in fuel-burning plants. May we impress upon you that public utilities are still looking to the metallurgists for metals that will permit them to go to 1000°, and in the AMERICAN WELDING SOCIETY lies the hope of the industry for making welding more foolproof. It is in the last decade that the metallurgists and welders have built themselves firmly into the power industry. The power industry realizes its indebtedness to them and places no small share of its future in their hands.

The advent of steam pressures up to 2500 lb. with temperatures up to 950° has made the selection and application of piping material one of the really major problems facing the mechanical engineer in power plant design. Although it is an extremely broad subject, it is the intent of this discussion to cover only two aspects: First, the requirements for satisfactory high-temperature piping; and second, the welding of such piping to produce the requisite safety in joint strength, structurally as well as metallurgically.

SELECTION OF TUBING MATERIAL

In 1928 and 1929, when one of the authors was intimately connected with the design of a power plant in which the boilers were to develop steam at 1250 lb. and 850°, he can well remember his search for information on creep behavior. At that time it was only a matter of a few weeks to read all the published articles available in the English language on the subject of creep. Now, however, if one were to begin at the beginning, it probably would be impossible ever to catch up to date with the literature on this subject. This is merely to emphasize the accomplishments of the metallurgists in their research in creep and the development of suitable alloys for service at elevated temperatures.

As a result of such development, it has been established that the prime requisites for tubing to carry high-pressure steam at 950° F. are the following:

First, a low creep rate to permit a thin wall tubing that will have flexibility and that can be properly worked.

Second, a stable material that will be resistant to internal change of structure and to external oxidation and corrosion.

Third, the workability of the material, especially in welding and in making bends during fabrication.

We have recently reviewed the suitability of a number of alloys that might possibly be better than carbon-molybdenum steel for use at 950° F. Because of the accompanying high pressure of 2400 lb. it was thought a stronger alloy might be desirable. Among other alloys, an investigation was made of one per cent carbon-molybdenum steel, chrome-molybdenum steels containing up to five per cent chromium, and chromium-silicon-molybdenum steel. While the addition of one-half per cent of molybdenum to carbon steel nearly doubles its strength at 950° F., as determined by creep rate, there is little further gain in going to a one per cent or higher, molybdenum steel. There is a question as to whether or not the alloys of the other types show a sufficient improvement in a reduced creep rate to justify their higher cost. This statement is true for all of the alloys except the Austenitic 18–8 stainless steel, but the use of this alloy is not justified for 950° F. service because of its high cost. Furthermore, available creep data on these other alloys show wide variations. Creep tests of carbon-molybdenum steels have shown almost as much variation in the past, but these variations have been subjected to much research which has shed considerable light on the cause of such variations. So far as we know, there is probably more research data available on one-half per cent carbon-molybdenum steel than on any other alloy, particularly research of a nature that it is believed will permit some degree of control of these creep variables. Consequently, a safe selection of design stress for the other alloys would be only slightly higher than for carbon-molybdenum steel so that the increase in price of the alloys is hardly justifiable at the present time.

The stability of the various materials was also considered. Under temperatures of 950° F., there is not sufficient evidence of serious attack on carbon-molybdenum steel by steam. A great deal of research work is now in progress which will give a clearer understanding of corrosion control.

Sub-microscopic changes appear to be taking place in

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† Engineering Department, American Gas and Electric Service Corporation, New York.

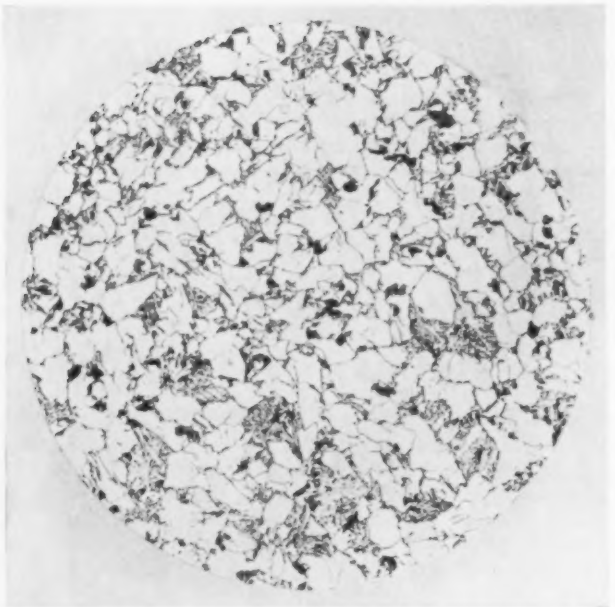

Fig. 1—C-Mo Steel. Grain Size 5. Acceptable Structure. 65 X

some steels which pronouncedly affect the hot ductility. This matter has been brought to the attention of American metallurgists by Bailey of England and has been confirmed by a number of investigations in this country. This condition, to date, has been observed only when the metal is overstressed, but the question still remains as to whether or not the alloys will exhibit the same type of brittle fractures when failure occurs in service. It is too early to comment much on this point. Carbon-molybdenum steels have been among those which have been found to develop this type of fracture. It is hoped that under normal stresses at 950° F. this condition will not be found to exist, although this phase of stability is one which still needs a considerable amount of further investigation.

Another change in internal structure which is found in steel is spheroidization and when it occurs it adversely affects the creep strength in small amounts. It is doubtful, however, if spheroidization would be found in carbon-molybdenum steel at 950° F., at least until after many thousands of hours of time had elapsed.

The weldability of the various alloys investigated was also an important consideration. The lower chromium steels, such as five per cent chromium, are martensitic and susceptible to air hardening. The austenitic chrome steels such as 18–8 would not be air hardening but would work-harden from chipping. Some of the other alloying elements such as silicon are oxidized in welding so that the deposited metal does not have the same characteristics as the parent metal. While good welds can be, and are being made in the chrome alloys, there is neither the ease nor certainty in securing full strength welds that there is in carbon-molybdenum steel. Furthermore, we do not have many welders available who are trained to work with other alloy steels nearly as well as with carbon-molybdenum steel.

As a result of the investigation, it was concluded that carbon-molybdenum steel is, at present, the most suitable alloy for use in steam piping operating at temperatures up to 950° F. However, may we again call attention to the need of further research to develop a material suitable at steam temperatures of 1000° F. We are ready to employ it just as soon as it is ready. Further study is needed on the alloys available so that the control of factors causing variations in creep rate will permit the setting up of standards of allowable design stresses. Welding technique for these alloys must also be developed more completely and the stability of some of them is open to question.

While the selection of carbon-molybdenum steel for 950° steam is justified, it is well known that wide variations of creep strength have been found. It is, therefore, of utmost importance to control the characteristics of the steel to preclude such variations. In this respect A. S. T. M. Specification A206 is not sufficiently exacting and should be revised. Perhaps the main deficiency in this specification is the omission of requirements affecting creep strength and probably the principal factor is grain size. Research work initiated by the General Electric Company and presented to the A. S. T. M. by Mr. Weaver shows much better creep strength for No. 3 to No. 6 grain sizes than shown by fine grain sizes.

There are also other factors having a decided influence on creep rate. One is the presence of ferritic banding. Spheroidization also increases the creep rate. This is the migration of the carbides into globules particularly at the grain boundaries. Although this takes place fairly slowly at 950° F., by starting with a steel which has the cementite well distributed in pearlitic form, a better over-all life as affected by creep is assured. Of course, the steel should be free from stressed grains as these tend to recrystallize at the service temperature and such rearrangement increases creep.

More recently, another important factor has been found to affect creep rate so much as almost to nullify the care used in controlling all other variables. This factor is the lack of uniformity of grain size sometimes called duplex grain structure. This refers to a mixture of large grains of, say, sizes 3 and 4 with groups of fine grains of size 8 or smaller. With such duplex grain structure, the creep rate may be four or five times the expected rate for a normal, uniformly grained steel. In addition, there are other creep strength variables introduced by the manufacturing process such as grain coarsening temperature which is influenced largely by the deoxidizing agent used in the manufacture of the steel. Too much aluminum inhibits grain growth and therefore

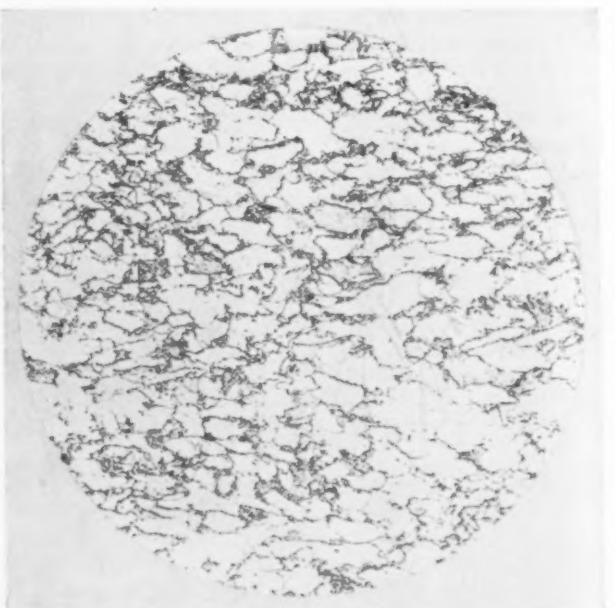

Fig. 2—C-Mo Steel. Grain Size 5. Shows Directional Characteristics of Grains, Indicating Steel Was Worked Too Cold and Not Annealed at a High Enough Temperature for a Long Enough Time to Produce Equiaxed Crystals. Type of Structure Frequently Characteristic of Stressed Condition. 65 X

raises the grain coarsening temperature which is undesirable.

From the foregoing it is obvious that to assure minimum creep rate, careful specifications and inspection are required. At this time it appears that microscopic examination of the structure offers more promise than any physical testing. It may, therefore, be suggested that carbon-molybdenum steel be specified in accordance with A. S. T. M. Specification A206, and supplemented by the following requirements:

1. The steel should have a ferrite grain size of A. S. T. M. No. 3 to No. 6 with preferred size of 4 to 5. (Fig. 1.)
2. It should be free from excessive ferritic banding. (Figs. 3 and 4.)
3. There should be no evidence of stress such as indicated by distorted ferrite grains. (Fig. 2.)
4. There should be no evidence of spheroidization.
5. A uniform preponderance of one grain size is much preferred to steels with a tendency to duplex grain structure. (Figs. 5 and 6.)

Fig. 3—Permissible Degree of Banding. 65 X

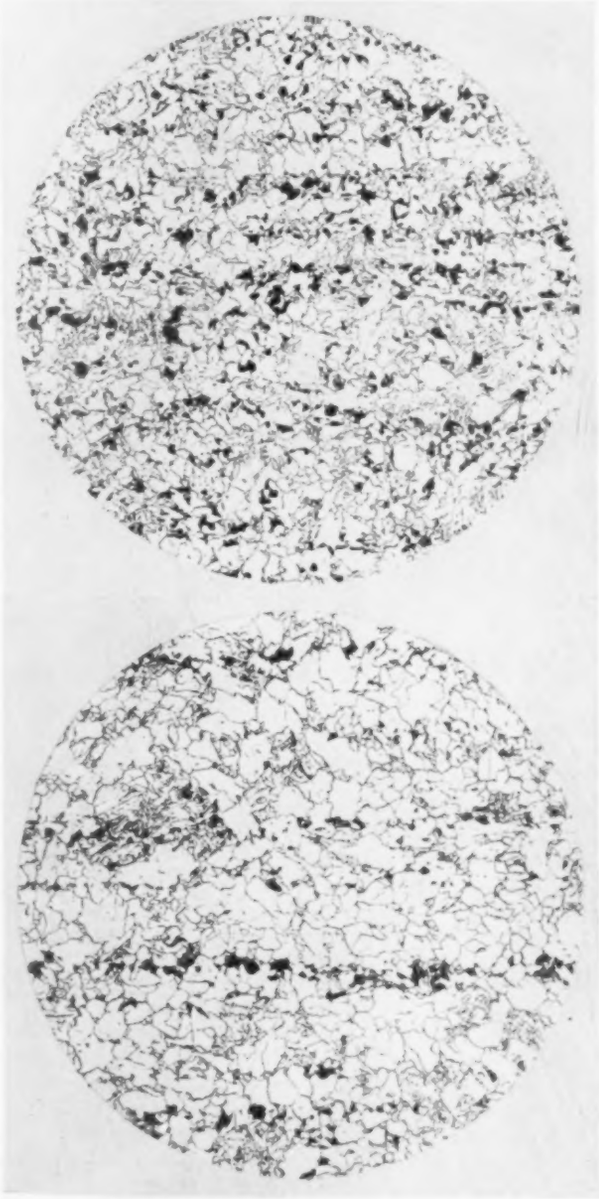

Fig. 4—Excessive Degree of Banding. 65 X

Fig. 5—Permissible Degree of Duplex Grain Size. 65 X

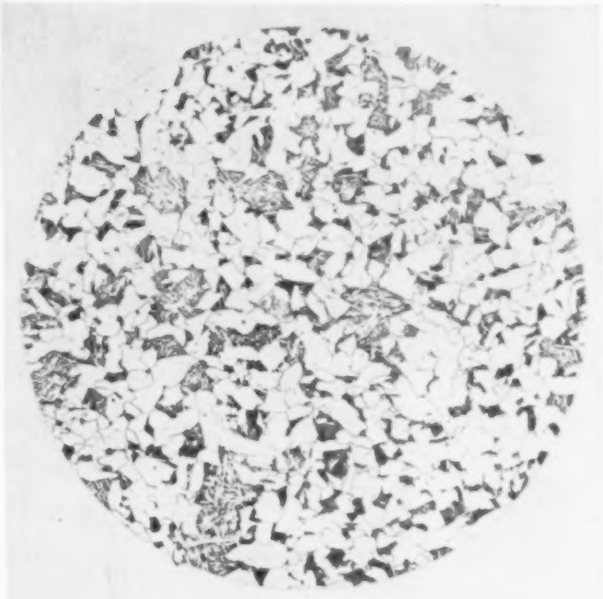

Fig. 6—Excessive Degree of Duplex Grain Size. 65 X

6. Steel should be of such composition and so manufactured that the foregoing requirements can be met by heat treatment at a temperature not to exceed 1700° F. with a draw temperature not to exceed 1200° F. Such heat treatment should be of a simple nature which can easily be accomplished in the average fabrication shops or in the field.

In order to define the above clearly, typical microphotographs might be included with the specifications.

WELDING TUBING JOINTS

Given good metallurgical conditions in the tubing, of which the foregoing discussion is as brief as could possibly be presented, it is the welder's responsibility to develop such technique that he can readily and surely join the material that the metallurgists have carefully provided.

The best of materials may be made quite useless by poor welding.

The advent of higher steam temperatures in power plants resulted in increased maintenance of flanged joints that would not stay tight chiefly because of the creep relaxation of the bolting. Therefore, it became necessary to adopt welding, and practically all present-day piping has welded joints. Several years ago, it was thought necessary to upset the ends of the tubing to secure a weld thickness greater than the parent tube wall thickness since at that time the production of sound welds was rather uncertain to say the least. As the art of welding progressed and it was demonstrated that upsetting the ends was unnecessary, attention was devoted to securing good welds having the same thickness as the full pipe wall.

The practice in oxyacetylene welding was to scarf the pipe ends and leave a space between them. This space was readily filled in with the rod so that a full depth weld could be obtained. However, with electric arc welding this became more difficult because of uncertain conditions at the root of the weld that permitted spatter and icicles to get into the pipe. Such extraneous particles are decidedly hazardous as they may pass into the turbine and other equipment, causing very serious damage. The backing ring was, therefore, developed which had the advantage of providing a bottom for the weld. Some engineers objected to the obstruction in the pipe caused by the backing rings and so a number of installations were made with upset pipe ends which permitted recessing the rings. This type of joint was installed in 1937 in the Logan plant of the Appalachian Electric Power Company. While there was no question of the adequacy of these welds, the actual field welding disclosed a number of difficulties, a few of which were:

1. The cost of upsetting came to about $60 for a 10-inch joint.
2. The rings had to be tightly fitted to the inside wall of the pipe to provide uniform backing around the periphery. If this is not done the flame of the arc blows through between the ring and pipe. This heats and softens the ring so it may sag from its own weight. The ring in that condition is more susceptible to burning through than a cooler, more rigid ring. There also results a poor metallurgical structure at the bottom of the weld.
3. Even with tightly fitted rings, the heat of welding tends to cause them to buckle, leaving open gaps, which again permit arc blow.
4. It was thought advisable to weld the backing rings all around the periphery to the inside of the pipe on the upstream side in order to prevent the danger of tack weld breaking loose and passing to the turbine and other equipment.
5. The first welding bead is expected to fuse the pipe ends to the ring. If the adjacent ends are not spaced sufficiently, it becomes difficult to fuse well into the ring and prevent the formation of voids in the corners. The minimum space between ends should be $1^1/_2$ times the diameter of the electrode, preferably twice the diameter and not less than $^1/_4$ inch. Even if the initial spacing is sufficient, the progress of welding draws up the gap and may cause side arcing from the rod instead of from the end of the rod.
6. The above difficulty with the first bead causes welding operators to tend to burn through the backing rings in attempting to secure good fusion in the root.

With the exception of the cost of upsetting, all the above comments apply equally to backing rings placed inside the pipe, as is now common practice. The importance of tightly fitting rings has been recognized in a recent design of backing ring developed by the United Light & Power Engineering and Construction Company and the Midwest Piping and Supply Company. This is a tapered ring which permits a tighter-than-usual fit.

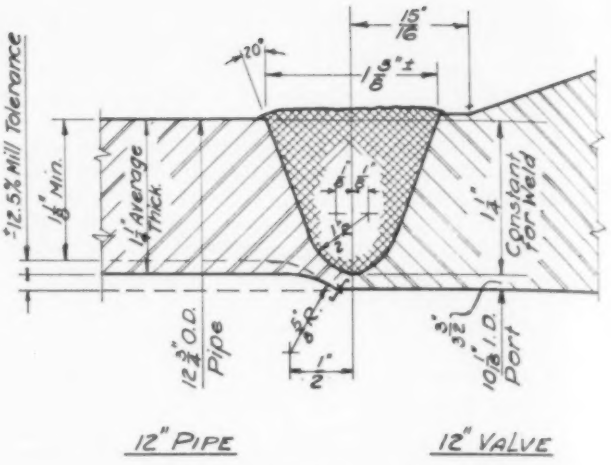

Fig. 7—Details of Amgael Joint

In view of our experience it became worth while to develop a weld joint design which would entirely eliminate backing rings. The result was a joint which, for want of a better name, we called the "Amgael" joint. Subsequent to its development, it was found to be similar to a joint for plate seams that was developed and patented by the A. O. Smith Corporation. The pipe ends are easily prepared by machining a rough half "U" groove. The protruding tongue is crimped or rolled cold toward the inside and final cuts are made on the inside ends and sides. Such machining is to a fixed inside diameter which produces a weld thickness at all times equal to the average pipe wall thickness rather than minimum tubing wall thickness. Furthermore, a better matching of the pipe ends is assured irrespective of rolling mill tolerances in the pipe (Fig. 7).

At the Windsor plant of The Ohio Power Company this joint proved very satisfactory. The pipe ends were simply butted together and held in place by a clamping rig. A smooth, flat surface is presented for deposit of the first welding bead and there is no space for arc blow and less danger of blowing through to the inside of the pipe. This last advantage is perhaps due to the better heat conductivity of the butting tongues of parent metal, whereas with the separate backing strip there is inadequate removal of the heat of welding. Over one hundred Amgael joints were made in our Windsor Station by the W. K. Mitchell Co., the piping contractor, and by Foster Wheeler Corp. on their boiler with only two minor cases of burning through, whereas our experience with backing rings has shown a much greater tendency to burn through and more seriously when it occurs.

Some question may be raised as to the completeness of fusion of the butting tongues and the possible effect of the remaining unfused depth which resembles a crack. We have, and can at any time obtain complete fusion of the tongues with careful control, but obviously this cannot be expected in field welding which must sometimes be done under extremely adverse conditions. Investigation, however, led to the conclusion that such lack of fusion is not dangerous and has little tendency to progress. Backbend tests invariably show full ductility but these, of course, are only a convenient means of checking the root of the weld as no service condition in

piping stresses a weld in that manner. Secondly, the unfused gap is *below* the pipe wall thickness so that any stress concentration caused by it is much less important than if it were *within* the inside surface of the pipe which would cause an interference with the flow of stress across the weld. In this connection, we have found that an under-cut in applying the final outside weld layer produces far more serious stress concentrations.

Sound welding of the Amgael joint requires proper technique and skilled individual workmanship. Numerous shop tests were run to establish the best welding procedure, i.e., preheat temperature, selection of electrodes, current and voltage regulation. In these tests it was found that mild steel electrodes for the first bead provided a more ductile material to reduce the ever present possibility of developing a crack at the root of the weld. Cracks may be caused by rapid chilling of the deposited metal or by some movement of the adjacent pipes that would place the deposit in a highly stressed condition. The mild steel deposited absorbed considerable molybdenum from the pipe material. The balance of the weld was done, of course, with carbon molybdenum electrodes. When the welding procedure had been established for the shop, each individual welder was trained in it and required to pass tests proving his proficiency.

An abstract of some of the salient features of the welding specifications will show the exacting requirement under which the work was performed.

1. No welding shall be done without the presence of the purchaser's inspector.

2. All welding of each Amgael joint shall be performed continuously to the completion of the joint. This will require the use of three eight-hour shifts. (An Amgael joint in 12¾-inch piping consumed an average of 20 hours.)

3. All welding faces shall be free from rust, scale, paint, oil or grease Where necessary, the weld faces shall be seared with an acetylene torch.

4. Joints shall be positioned and held by welding "C" clamps across the groove to assure proper alignment and butting of the ends. No tack welding in the groove will be permitted.

5. Before welding, all mated parts shall be uniformly preheated to 500° F. maintaining not less than 450° F. throughout the welding period. At no time shall temperature drop below 300° F. until the joint is completely stress relieved. Preheat temperatures are either continually recorded by recording instruments or are checked at frequent intervals with portable surface pyrometers and the temperature recorded.

6. The Contractor shall use a recording voltmeter and an indicating ammeter in the welding circuit on all welds. Where such instruments indicate an erratic arc, the weld deposit shall be chipped out. The voltage swing should be held to within plus or minus 5 volts beyond the correct voltage for the approved technique. The instruments should be of a reliable and sensitive type.

7. Each bead of weld deposit shall be chipped and cleaned to remove any cavities, slag and dirt inclusions, cracks, undercutting of the parent metal, improperly fused weld metal. This shall be followed by inspection with a magnifying glass.

8. Each individual welder is assigned a symbol and a record sheet shall be used for each weld so that the individual welder is identified with the work. (This, together with recording voltmeter chart and log of pyrometer readings on electric preheating and stress relieving outfit, gives a valuable history for each weld.)

9. The outside row of beading shall be smoothly and uniformly deposited to at least an ⅛ inch projection outside the pipe wall and tapered at the edges to the adjoining pipe wall without overlap or undercut. If necessary the outside bead shall be chipped or ground smooth to remove overlaps or pits which might lead to fatigue failures.

Even with the most skilled welders and well proved technique, the production of sound welds is dependent on the man himself. The use of X-ray for weld inspection has found some favor and is undoubtedly of considerable value particularly in establishing procedure and training welders. On the other hand, X-ray inspection of field welds is costly, nor is such an inspection 100 per cent reliable. Finally if such inspection discloses defects, there may be much chipping, second setting up of preheating coils, rewelding and re-stress relieving, to be done.

At the Windsor plant it was decided to employ a man-to-man inspection system which was first successfully initiated on the Logan welding. In this method, the purchaser's inspector watches each weld and has a constant check on the workmanship. Defects are promptly and easily corrected. The expense of such inspection is less than X-ray inspection.

In addition to the man-to-man inspection, the recording voltmeter acts as a supervisory instrument. While the maintenance of close voltage may not be absolutely essential, the graphic record shows the welder's steadiness and ability to produce welds equal to his tests. Physical disability, lack of sleep, or partial intoxication will show up in a poor chart record.

The man-to-man inspection system, along with the various instruments, have been able to hold the welders to the correct technique; thus eliminating the possibility of the welder changing his technique as he goes from overhead to down-hand welding, such as changing heat or size of electrode, which would result in a variation of fusion, variation of the heat input, a greater deposition at the top of the weld than at the bottom, undue distortion from welding, and the production of an inferior weld in the bottom half.

Results of good inspection and observation are also noted by the fact that on one job 102 inches of cracks were found and eliminated and 325 lb. of defective electrodes or electrodes causing trouble were rejected from the job. At another time a certain make of metallurgically right electrode was found to be entirely too difficult for the average skilled operator to handle in an overhead position.

It will, of course, be realized that this dissertation necessarily only hits the high spots and that much underlying work is required to decide each factor no matter how insignificant it may appear at the time. Suffice it to say that even the best metallurgical and welding conditions are never too good, and that no effort should be spared to get the best that can be obtained. We hope we have called to your attention the incompleteness of our present knowledge and the reliance of power plant engineers on metallurgists and welders to help us in the future.

May we take this opportunity to acknowledge the valuable cooperation of our consultant, Professor A. E. White, Director of Research at the University of Michigan, and to Mr. E. T. Davis, our Chief Welding Inspector on the Logan and Windsor jobs, and Master Mechanic at our Twin Branch Plant.

THE DILAGRAPH

By E. D. SODERSTROM*

THE problem of visualizing what happens in a piece of steel as it heats and cools is directly involved in all forging, heat treating and welding operations. To aid students in understanding this, I devised an apparatus I call a "Dilagraph," by means of which the steel draws its own "picture." This makes it possible to "see" the critical zones and leads to clarification and better understanding of the Thermal Equilibrium and Heat Treating diagrams.

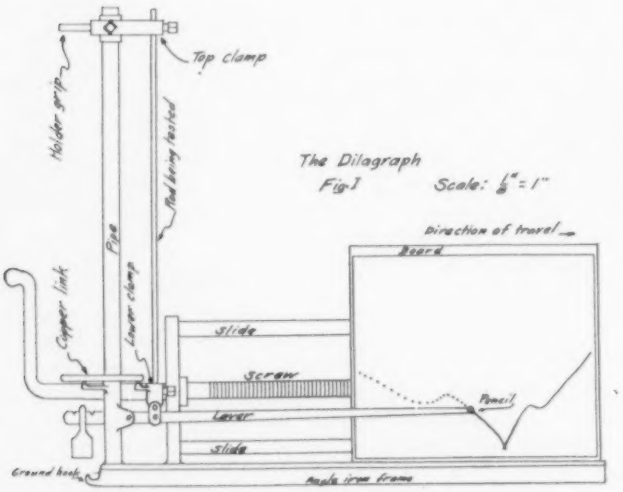

Fig. 1

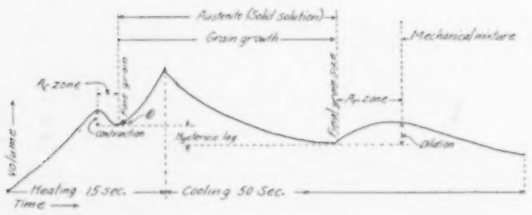

Fig. 2—Dilagraph. The Above Graph Was Obtained with a 3/16 In. x 21 In. Steel Rod (S.A.E. 1090) Using 200 Amperes. The Ac Zone Is the Critical Temperature on Heating, About 1340° F. The Ar Zone Is the Critical Temperature on Cooling, About 1270° F. Austenite Has a Closer Packed Atomic Arrangement Than Pearlite. Steel Consequently Cools and Contracts While Absorbing the Heat of Solution. On Cooling It Reverts to the Original Form Again and as the Energy of Solution Passes Out, Heating and Dilation Occur. Proper Quenching Temperature Is at ①. If the Cooling Through the Ar Zone Is Slow Enough, All the Heat of Solution Passes Out, Austenite of Eutectoid Composition Converts to Pearlite, Excess Constituents Settle Out and a Condition of Thermal Equilibrium for Temperatures Under the Critical Will Exist. The Steel Would Be "Full-Annealed" and in the Mechanical Mixture Condition. Due to the Rapid Contraction Through the Ac Zone Heating Steel for Hardening Must be Done Slowly. For the Same Reason Steel Over 0.40C Must Be Preheated Before Arc Welding. Rapid Heating Produces Strains That Result in Cracks on Quenching

The essential features of the apparatus consist of the following: A balanced lever arm to which is attached a clamp to hold one end of the rod being tested; a screw actuated slide bar to which the board holding the paper is attached; a flexible, balanced copper cable link to the lower clamp; an insulated top clamp with copper cable connection. Current from an arc welder is used in operating the dilagraph. The cable connection to the top clamp is gripped with the electrode holder and the ground cable is hooked onto the frame of the machine thus completing the circuit. By means of the hook on the ground cable, the "heat" may be turned on and off at will.

The sketch Fig. 1 shows the general appearance of the dilagraph. A general description of a graph is given in Fig. 2 while Fig. 3 is a schematic interpretation of the dilation period. Figure 4 shows a group of graphs as taken under identical conditions for the purpose of securing comparisons between different kinds of steel.

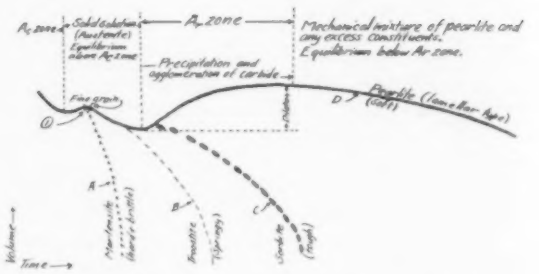

Fig. 3—The Dilation Period (Schematic). The Physical Characteristics May Be Attained by Controlled Rate of Cooling as Represented by Curves A, B, C and D. Steel in Any One of These Stages Will, if Reheated, Continue to Transform. Since It Is Easier to Control the Reheating Than the Cooling Rate, the Usual Method Is to Quench at ① so as to Produce a Hardness Somewhat Greater Than Wanted, Then Reheat, Called "Tempering" or "Drawing" Until the Desired Condition Is Attained. Full Anneal Is Attained by Cooling at Rate "D" Wherein Complete Dilation Has Occurred and the Steel Has Had Time to Transform to Complete Thermal Equilibrium for Temperatures Below the Ar Zone. It Should Be Noted That Slow Cooling Direct from Austenite Produces Lamellar Carbide Structures, but Reheating These or Reheating Quenched Steel Produces Globular or Spheroidized Carbide Structures

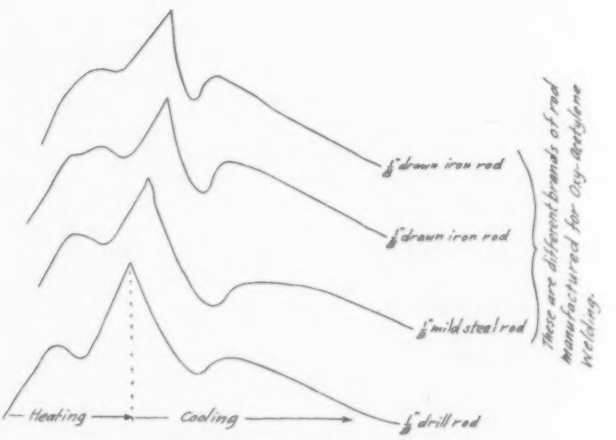

Fig. 4—Graphs as Taken

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WELDING IN A STEEL MILL*

By R. P. PALMER†

THE modern steel mill has long recognized the value of welding as a method of repairing broken and worn equipment, but in most cases has not taken full advantage of the savings that can be realized if welding is used to the fullest extent.

For instance, I know a certain steel mill employing eight (8) welders while another mill of equal size and production capacity employs thirty-five (35) welders. It is very evident the first mill is not taking full advantage of welding. Having friends in both mills, I decided to get some first-hand information about welding in these two mills.

MILL WHERE WELDING IS NOT FULLY UTILIZED

In the first mill, where eight welders were employed, they were divided among the departments as follows: three (3) in the Pipe Shop, two (2) in the Boiler Shop, one (1) in the Machine Shop and one (1) in the Forge Shop, and one (1) in the Open Hearth.

I found four (4) different makes of electric welding machines and no spare parts for any one of them. As for welding electrodes, each welder had his own favorite brand and the same was true of gas welding and cutting equipment. Repair work on the gas welding and cutting equipment was done by the manufacturer. This, of course, made it necessary to have extra equipment on hand to use while torches and regulators were at the factory for repairs. The welder who showed me through the plant pointed out a job that had just been completed and it was riveted. He stated that this particular job would have been much better if it had been welded. He had suggested that it be welded; however, he was informed that if the welding process was used, the riveters would complain about their work being taken from them. He was also informed that if they were to weld everything possible it would be necessary to purchase additional welding machines and employ more welders which would result in the elimination of the riveters. The drawings from the Engineering Department had specified rivets and there was no alternative but to rivet the job.

In the Pipe Shop conditions were considerably better, practically all piping installed being welded. The welders performed the layout and fitting work and when welding was not needed they performed the duties of pipefitters.

In the Forge Shop the welding was done by one of the blacksmiths as there was very little welding done.

In the Open Hearth the welder repaired leaking doors and frames for the furnaces.

The welder in the Machine Shop was the only welder in the plant who had sufficient work to keep him welding for the entire eight hours and he informed me that enough worn parts were scrapped and replaced by new ones to keep another welder busy in the Machine Shop working full time.

In talking with several department superintendents regarding welding, they all had the same story—"When we have a breakdown, the welder from the Machine Shop comes to do the repair work and needs help but the welders in the other departments are not available without considerable arguments, and if you do get one he has never welded anything but pipe, or he is a gas welder only, or vice versa, or the Boiler Shop welder has a set of flues to weld; therefore, we have reached the point where we do not try to get welding done. It costs a lot to have a large number of spare parts on hand, but there is nothing else to be done." We inquired of them if they ever called in a representative of a welding supply company and they advised they had requested visits from service welders but the shop purchased their equipment and supplies from so many different companies that they did not buy a great amount from any particular firm and as a result did not have much prestige from that angle. They stated they had discussed the need of more welding and more welders with the management and they always received the same answer, "we have had the same number of welders for ten or twelve years—why are more needed at this time?" Apparently no one had endeavored to answer that question.

WELDING AN IMPORTANT DEPARTMENT

In the second mill, they employed thirty-five welders and they were in charge of a welding foreman. If the Pipe Shop had a pipe line to be welded, the pipefitters made the layout and performed the fitting, and when the line was ready to be welded, a welder from the weldery was asigned to the job and completed the welding.

All welding machines were of the same manufacture and the spare armatures would fit any one of the machines. All welding and cutting regulators were of one make, as well as cutting and welding torches. A repair shop was provided for the maintenance of all welding equipment and this shop also made 30 day inspections of all cutting and welding equipment and reported their condition to the Safety Department.

The writer requested the welding foreman if he would furnish an outline covering the organization, equipment, management and conducting of a plant weldery in a modern steel mill and the following is just as he gave it to me.

PLANT WELDERY

"Most plant welderies start with a cutting torch and electric welding machine, and by making themselves absolutely indispensable, they grow until they equal any service department in the organization for size, number of employees and amount of money saved.

* Presented at Annual Meeting, A. W. S., Chicago, Oct. 23 to 27, 1939.
† Welding Foreman, Wheeling Steel Corp., Steubenville, Ohio.

"With a start such as this, it is only natural that the Welding Department is located in a corner of some other department and the only way you can get out of the corner is to sell welding. Let's assume that we have now reached the point that the corner will no longer serve our purpose. The boss has decided we need larger quarters and some of the equipment we have been asking for so long, and we are to have a voice in the new location and equipment.

"The building should be fireproof, conveniently located to the Store Room, Forge Shop, Machine Shop and Pipe Shop. We need a truck and railroad entrance, overhead crane, gas, air and water lines large enough to insure an adequate supply at all times. The building should be well lighted and ventilated and locker room and individual lockers should be provided.

"To equip the shop we need:

New welding machines and accessories of high amperage. (In our line of work it is advisable to obtain equipment of larger capacity, rather than overload smaller units.)
Headshields and necessary safety apparel should be provided.
Hand and mechanical gas cutting equipment for cutting shapes.
Sufficient stock of plates, bars and rolled shapes.
Ample supply of welding electrodes, to be able to take care of any unforeseen emergency that may arise.
Plate rolls, shears and press, the press to be used for forming and bending, also for straightening work after welding is completed.
Face plates for setting up work, of sufficient size to accommodate any job in your own particular industry. (Plates for steel mill work should be at least 6 ft. x 14 ft.)
Position finders, or welding manipulators as your work requires.
Furnace for stress-relieving after welding.
Overhead electric crane (for steel mill work should be at least 15-ton capacity), jib cranes and chain blocks.
Screw jacks of various sizes.
Air hammers for chipping and peining.
Air motors for drilling and reaming.
Air grinders of various sizes.
Portable preheating torches (these can be made of pipe by welding) for localized heating.
Jigs and fixtures for production or repeat jobs, these to be fabricated by welding, for individual jobs.
Drill press.
Tool room for storage and maintenance of equipment and hand tools.

"We now have the building and necessary equipment. Our next job is to sell the services of our department on a larger scale, but we find plant welderies having for customers the plants of one company only, have no one on the payroll classed as salesmen; however, a lot of selling is required to keep a welding department of this type busy and progressive. In fact, every man in the department must be a part-time salesman. For example, a welder is repairing a cast-iron door frame in one department and mentioned to the millwright that he had made welded steel door frames for a furnace in another department and explained some of the changes and improvements that had been made on the new frames. The millwright told the department Master Mechanic, who immediately investigated and found this new door frame to be just what he wanted, resulting in his ordering a new set of frames.

"This is a very effective method of selling welded products, as you have something to show which can be compared to parts made by other methods. In cases where you have no sample for inspection, verbal description or pencil sketches must be used. In other words, you must sell the department head something you do not have and to do this you must get his confidence. Once this is done, do not lose it at any cost as that is the one thing that beats lower prices, better delivery dates, or most anything else you can mention.

"Another selling method we have found very successful was having welding meetings each month during the winter season, inviting different welding equipment manufacturers to furnish speakers and pictures on welding. (You will find they are very willing to cooperate with you in this respect.) Master Mechanics, General Foremen, Millwrights, members of the Engineering Department (especially those designing welding) and the entire personnel of the Welding Department are invited. Suppose we have several Master Mechanics to whom we want to sell a certain welding job. We have the speaker describe the work in question, or some similar job. Also he shows pictures of the actual fabrication, or of the job being described. He gives costs, time required and money saved by welding. In addition to aiding us to sell our department, these meetings prove very much worth while to the Welding Department personnel from education standpoint. Not to be overlooked is the company magazine or whatever publication is used. By taking advantage of this medium, pictures, prints, sketches and descriptive stories of jobs being done in the weldery can be placed in the hands of everyone interested. In addition to the above methods of selling welding, the Welding Foreman must contact department heads and Master Mechanics at regular intervals, discuss welding problems and inform them regarding the amount of time and money they have saved by using welded construction on some particular job that has been done for their department.

"In most Engineering Departments, certain engineers are assigned the work of welded design. It is necessary that the Welding Foreman confer with them and lend all the assistance possible. We invited them to our welding meetings, suggested and loaned them books and magazines on welding and welding design, secured data for them on the strength of the various types and kinds of welds, called them to the shop to inspect jobs they had designed while the job was in the course of construction; conducted tests, both physical and chemical, to show the engineer what should and should not be done and explain the reason.

"In steel mill work you often get breakdown jobs on which there is no time for engineering design. In cases of this kind you duplicate a casting with plates and shapes welded together. There is very little chance to go wrong on this class of work as you can bring the broken casting to the Welding Department and copy.

"Engineers experienced in casting design will usually design a welded shape much heavier and stronger than necessary, also he will add ribs where they are not needed. In casting, some ribs are added to insure flow of metal where desired, but these are not needed in welded shapes. Weld designing in a weldery is more difficult than in a production shop where the same class of work is done day after day, the only difference being in the size. In a plant weldery almost every job requires individual designing. Most authorities agree that an engineer who has had no experience on casting design will pick up weld design more readily than one with a lot of casting experience. Regardless of the experience the designer has had on welding it is best that the Welding Foreman

check the drawings as the work of designing progresses. This writer knows of several mill welderies with an unusual engineering set-up that has proved to be very satisfactory. They have welders with eight or ten years' welding experience, who with the aid of a correspondence course and night study have acquired sufficient drafting and engineering knowledge to do a first-class job of weld designing. Their welding experience gave them quite an advantage over the engineer without such a background.

"Work in a steel mill usually originates with the department Master Mechanic. He has machinery which he wants enlarged, remodeled or changed, or perhaps desires construction of new equipment. He studies his needs, discusses them with the Operating Superintendent, who, by the way, is the one who pays for all new or changed equipment in his department. If he agrees, the plan is next discussed with the General Master Mechanic, whose job it is to decide if, how, when and where the work is to be done. If the department Master Mechanic, Superintendent and General Master Mechanic are weld-minded, the Welding Department already has an advantage. How does one go about getting these men weld-minded, you ask. By past performance of the Welding Deparment. If every job done by the welders was done as if their life depended on it. If these men have never been disappointed in a job from your department, then you can be sure they are weld-minded. In other words, everything depends on that one factor we mentioned previously—confidence. Now to get back to the job. The General Master Mechanic secures existing prints or has sketches made of the proposed job, and foremen whose departments may be able to do the work in question each give an estimate on cost and date work will be completed. The General Master Mechanic, from the information at hand, will then decide what department will do the work. He has submitted a price to the Operating Department and they give their approval by issuing a shop order covering the work to be done. The Engineering Department now starts work designing the job from an engineering standpoint to determine load, stresses, size and members and, incidentally, size of welds as this is to be a welded job. This is the reason the General Master Mechanic decided to use welding.

"The shop order called for three (3) water-cooled Soaking Pit rails. All other departments except the Foundry and Weldery are eliminated by the nature of the job. Comparing the schedules of the Foundry and the Weldery, we found the second rail would be completed on the date the pattern work would have been finished, and on that same date the first rail we made would be in the Machine Shop and all machine work completed. The saving, according to the estimate, was only $40 on each rail but this did not include the pattern cost which represented several hundred dollars; however, the amount saved by the difference in the cost of rails and the cost of the pattern was small compared to the amount saved by getting the Operating or Producing Department started several days sooner than it would have been possible to do had they depended on castings. Incidentally, making it possible to start the Operating, or Producing Department several days sooner resulted in making delivery of certain orders of steel plate on the date the Sales Department had promised. The two main reasons for deciding on welded construction were the saving of money and time.

"After the shop order is received at the General Master Mechanic's office, job cards are made out for each job, prints attached and delivered to the departments which are to do the work. When work is completed, this job card serves as a cost record, as all pertinent facts are shown, such as:

Steel plates and shapes	Size, weight and cost
Layout time	Hours and cost
Machine or hand-cut	Hours and cost
Oxygen and acetylene	Cu. ft. and cost
Set-up and tack	Hours and cost
Welding	Hours and cost
Electrodes	Size, weight and cost
Welds	Size, length and cost
Stress relieve	Hours in furnace and temperature
Inspection and test	Hours and cost
Grinding and painting	Hours and cost

"Check number of welders, layer-outs, cutter and inspector, and amount of time each worked. The cost of current is estimated from the number of hours the welding machines were in operation. Miscellaneous information, such as crane and truck service, etc., is shown. Shop Burden, or Overhead, is added at the Mechanical Office, after the work has been completed. This cost record gives you an opportunity to check your original estimate. As the job progresses, analyze the job occasionally and if you are not on schedule, extra help may be necessary

"Cost records of this kind are a great help in estimating work; in fact, past records and experience are about all you have with which to prepare estimates. There are a number of charts available showing length and size of weld, amount of current, size and weight of electrodes deposited, and time required; however, no two shops are equipped alike, therefore it would be impossible to have one yardstick that would measure all welding jobs.

"The method of layng out that serves our department best is as follows: When job cards and prints are received for a new job, the workman who is to be assigned on the job is called in and the job is gone over carefully, plans are discussed and decided upon. The man who does the laying out also fits up the job and has help to do the necessary cutting and tacking, but he must put the job together ready to weld then if it does not fit he knows who is at fault. Each welder working on a job stamps his check number at the start and stop of his weld and he understands very distinctly that he is responsible for work he does. This helps to maintain a high standard of workmanship. In some cases coupons are cut and tested, but in most of our work this is not practical. For our particular kind of work, the best method of inspection is visual examination during and after welding. Each welder is required to make test welds every 60 days. Final checking, inspecting and testing should be done under the supervision of the Foreman or Assistant Foreman, but all work that requires machining should be checked by the Machine Shop inspector before leaving the weldery.

"Selection of welders is probably the most important item in the Welding Department, because the work you turn out is no better than the welders who do it. There are few jobs in which the human element enters into to such an extent as in welding; it is, therefore, of paramount importance that welders be selected who are liable, conscientious and dependable. We use the apprenticeship system for training our welders, requirements being high school education, physical fitness, residence in the immediate community, and to have worked in the General Labor Department for a period of time during which they have had an opportunity to learn what hard labor really is. They are taken for a probation period and if they do not make good in that length of time are then transferred to another department.

"Our welding course has been copied from courses used by several of the leading welding equipment manufacturers to train welders. After a practice period the apprentice is assigned to tacking with the layer-out

and as he progresses he is advanced until he has worked in all departments on all classes of work. Steel mill work usually requires about two years.

"In conclusion, just a few words about looking at welding jobs in different departments. Suppose there has been a breakdown and you are called to inspect the job. When you go to that department, you see the department Master Mechanic at his very worst. He is in trouble and wants you to get him out and do it quickly. Anything you do for him at a time like this will be remembered, so particularly at this time be diplomatic and at the same time 'get him out of the grease,' if it takes all the welders you have. If you do this you can be sure this man will be weld-minded."

MODERN METHODS IN THE DESIGN and Manufacture of an 80-Ton Gantry Crane*

By PAUL CODDINGTON†

THE use of modern arc welding in a wide range of applications is exceptionally well demonstrated in the design and construction of an 80-ton gantry crane by the Lakeside Bridge and Steel Company of Milwaukee.

Six of these cranes were ordered by the Tennessee Valley Authority. Of these six, two cranes were completed early this year (1938) and are now being used by the TVA for lifting the intake and spillway gates at the Pickwick Landing Dam on the Tennessee River in Hardin County, Tennessee. Four additional cranes are now under construction, and will be used for the same purpose on the dams at Guntersville, Alabama, and Chickamauga, Tennessee.

The crane was designed by the company's engineers to meet rigid Government specifications, and all of the cranes are guaranteed by the company as to performance and against defective workmanship and material for a period of one year after being put into operation. Inasmuch as time was the essence of the contract, no attempt was made to displace castings or riveted structural steel members just for the sake of using welded construction. However, for those parts where welded construction provided definite superiority over the orthodox castings or riveted members, the engineers made full use of their experience with time-tested and proved welded construction. In several parts, such as the hubs for drums and trucks, steel castings were combined with welded steel plates, providing a very economical and substantial design. The result, both in the performance and in the appearance of the crane, has more than justified their expectations, and has fulfilled the requirement of the Government engineers that the crane be built to conform to the most modern practice in the manufacture of structural steel and machinery.

* Submitted in connection with the James F. Lincoln Arc Welding Foundation Contest.

† President, Lakeside Bridge and Steel Company, Milwaukee, Wis.

Fig. 1—Shows First Crane Erected, and Second Crane on Barge Ready for Unloading

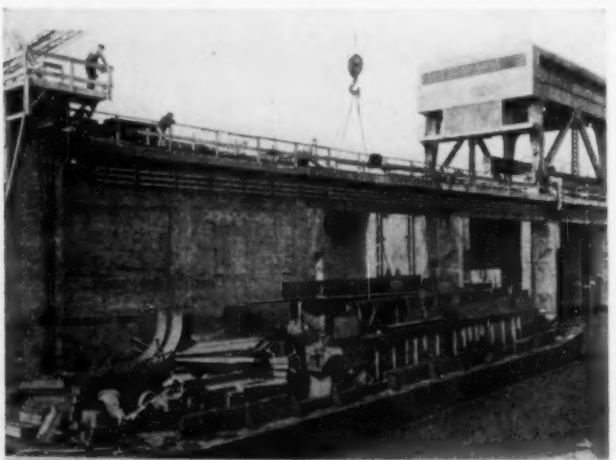


Fig. 2—Shows First Two Cranes Erected

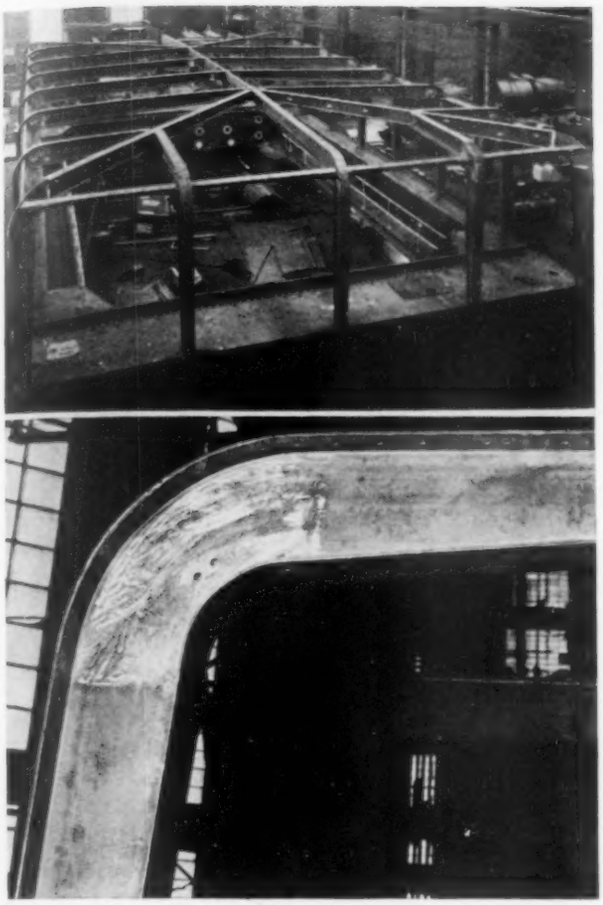
GENERAL DESCRIPTION OF THE CRANE

The crane under consideration is an electrically operated gantry, having a double-drum main hoist of 80 tons lifting capacity, mounted on a trolley of conventional overhead crane type, which, in turn, is supported by a gantry bridge. This gantry bridge is provided with four 2-wheel trucks and a driving mechanism for moving the bridge along the rails on the dock at the dam site.

The trolley carrying the hoist drums has a span of 47 ft. 0 in., and a lateral movement of 20 ft. 0 in. The gantry bridge has an over-all height of 38 ft. 5 in., a length of 60 ft. 0 in., and a span of 32 ft. 0 in. The total weight of the crane is 241 tons. Figure 1 shows the first crane in place at the Pickwick Landing Dam, and the second crane ready for unloading from a barge. Figure 2 shows both cranes erected on the dam.

STRUCTURAL STEEL FRAME

The outstanding application of arc welding in the structural part of the crane is in the design of the sup-



Figs. 3 and 4—Show Design of Supports for Machinery House

ports for the machinery house, shown in Figs 3 and 4. This machinery house, shown assembled in the shop in Fig. 5, covers an area 32 ft. 6 in. x 56 ft. 0 in., providing a clear space for the operation, inspection and servicing of the hoisting machinery, trolley drive and bridge drive machinery. A conventional design would require the use of either beams or trusses to support the sheet metal roof. Since neither standard beams nor trusses would give the desired lines on the exterior, an arched rib was designed, similar to those used recently in the construction of gymnasia and armories, to take the place of a column and roof beam, thereby giving a pleasing appearance to the interior as well as the exterior of the machinery house, and providing maximum strength with minimum weight, all at a reasonable cost for fabrication.

A wide flange beam was used to make the arched rib, a "V"-shaped section of the web being cut out on each side of the bend, and the flange closed in and welded to the web, giving a section of the desired shape and strength. Figures 3 and 4 show this arched rib construction.

In designing trucks for the trolley, and trucks to carry the gantry bridge, the engineers found the use of arc welding to be particularly advantageous. Figure 6 shows both the bridge and trolley trucks in an inverted position. By using a box design, with mild steel plates and bars of suitable thickness for the web, flanges and stiffeners, the material could be placed to the very best advantage to provide both strength and rigidity, without the usual hampering restrictions of foundry practice. The hubs of the bridge trucks were made of cast steel because no standard rolled section would serve the purpose as well as a casting.

MACHINERY

Maximum advantage for arc welding came in the design of the machinery. The main hoist drums, each designed for a cable pull of six tons, were made of rolled steel plates. For the barrels of the drums, a plate $2^{3}/_{4}$ inches thick was rolled to an inside diameter of $60^{3}/_{4}$ inches, which allowed $^{3}/_{8}$ inch for machine finish. The edges of the plates were scarfed for the longitudinal welds, and, after welding, the plates were rerolled to insure accuracy in the diameter. The ends of the drums were then counter-bored to receive the diaphragms, which were also built up, using a cast steel hub, with plates and bars for webs and stiffeners. These diaphragms were machine-turned on the outside to insure an accurate fit in the drums. Figure 8 shows a close-up view of a drum end before cleaning and machining. Figure 7 shows two of the drums after machining.

The designs of bearing supports, gear cases, jib crane for trash rack hoist, sheave supports, gear guards and wheel guards were all simplified and improved by the use of bars and plates formed to proper size and shape and arc welded to form a single piece. Figures 9, 10 and 11 show a few of these parts.

In the use of welded parts instead of castings, the designing and production engineers were free from those restrictions and limitations which even the most modern foundry must impose on all users of castings. Some of the more important of these restrictions are the unpredictable shrinkage and warping, sand-pockets, blow holes, hard spots and hidden defects which might not show up until after machining. Also, the engineers could place the metal to better advantage, giving maximum strength and rigidity with minimum weight. Aside from saving in first cost and in time of manufacture, those machine parts which are made of welded steel can be altered or repaired more readily than if they were made of cast metal—especially cast iron.

GENERAL NOTES ON FABRICATION

Materials, such as plates, bars and structural shapes, that were used in making up welded machine parts, were especially prepared before assembly. All pieces were cut accurately to shape and size with an oxygraph torch. Edges of stiffener angles and bars were milled to a bearing fit on the adjacent parts, and all pieces were made

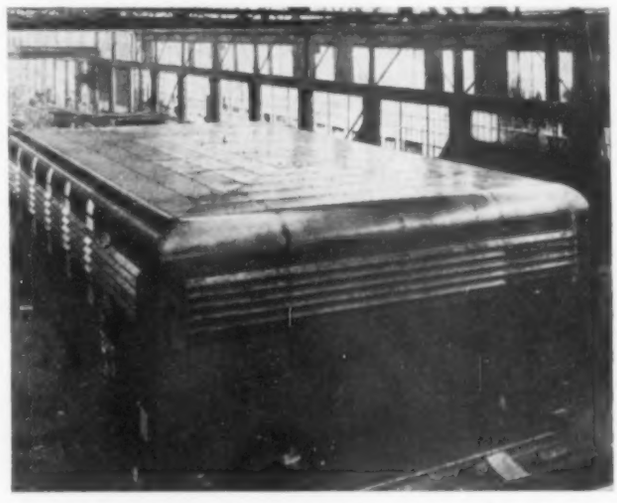


Fig. 5—Shows Machinery House Assembled in the Shop

perfectly straight, or bent to a template, as required, in a bending brake or in a hydraulic press. To insure uniform fillet welds and to prevent undercutting, the various pieces were held in proper position for welding by special positioning fixtures or machines. These fixtures and machines also increased the speed and efficiency of the welding operators.

All welding was done by government-certified welders under rigid inspection. Covered rods were used throughout, carefully selected to insure uniformity in the welds. Where the welds shown on the drawings were too heavy to make with one pass, each layer of metal was peened with a pneumatic hammer to relieve internal stresses before applying the next weld. All parts carrying heavy loads, such as the trucks, drums and gear cases, were normalized at a temperature of 1000 degrees after welding and before machining. All gear cases were sand-blasted on the inside to remove mill scale and to clean the welds.

COMPARATIVE COSTS

Complete and accurate records were kept by the company showing the actual cost of welded structural and machinery parts for these cranes.

The cost of welded machinery parts, as compared to the cost of castings, indicated a saving of about 15 per cent. A comparison is given in the following schedule (*for one crane*):

Using Castings

	Weight, Lb.	Cost	
Material:			
Cast Steel	15,500		
Cast Iron	50,750		
Structural Steel	28,250		
	94,500	$5216.00	
Labor (direct)		425.00	
Overhead Cost		544.00	
Total			$6185.00

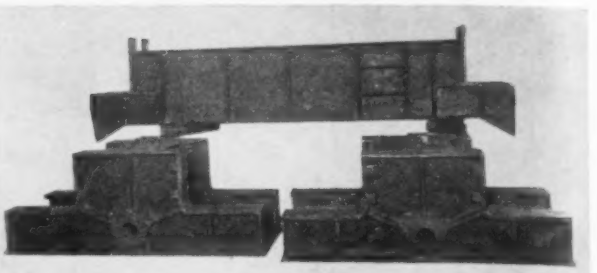
Using Welded Parts

	Weight, Lb.	Cost	
Material:			
Cast Steel	2,500		
Welding Wire	1,500		
Structural Steel	77,000		
	81,000	$2940.00	
Labor (direct)		1020.00	
Overhead Cost		1304.00	
Total			$5264.00

For One Crane:		
Saving on Material (13,500 lb.)		$921.00
Saving on Patterns		1050.00
For Six Cranes:		
Saving on Material and Patterns		$6576.00
Additional Overhead Earned for Manufacturer		$4560.00

These savings, of course, do not reflect such items as the saving in time and labor which might have been lost in rejected castings, or the lower cost of machining welded parts because of lighter finish and the absence of sand and hard spots, or the very great saving in time which would have been required to make the castings in the foundry. Also, at least four weeks were saved in the time which would have been required to make patterns. In addition, a very material advantage came in the opportunity to design the parts to suit the structural material in stock, instead of waiting on mill shipments. All of these time elements were of the utmost importance in a contract carrying a heavy penalty for failure to deliver on time.

Fig. 6—Shows Bridge and Trolley Trucks



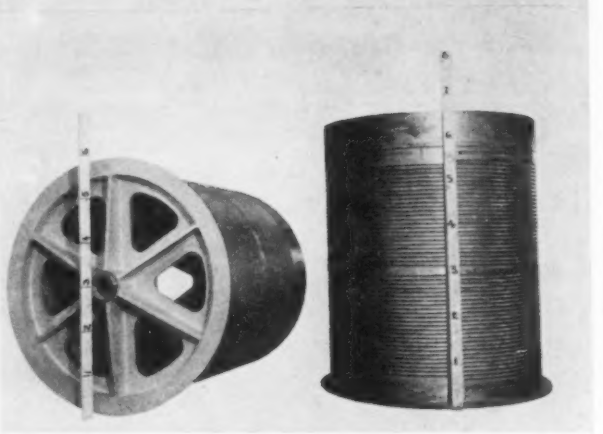


Fig. 7—Shows Drums, After Machining

Altogether, the total estimated saving in time (in making drawings, procuring materials and manufacturing) amounted to 40 days for *each* crane. Since the Government engineers, when evaluating the bids, calculated the value of time at $100.00 per day per crane, the total value of the time saved would be $24,000.00 for six cranes. This amount, added to any bidder's price, could readily mean the loss of the contract to another bidder. The first crane was delivered on time, and the second crane was delivered two days ahead of time. The last four cranes, at this writing, are in the process of manufacture, under a schedule which will insure delivery on time.

Based on actual experience, covering a wide variety of hoisting machinery, the company manufacturing the cranes herein described has found that actual savings

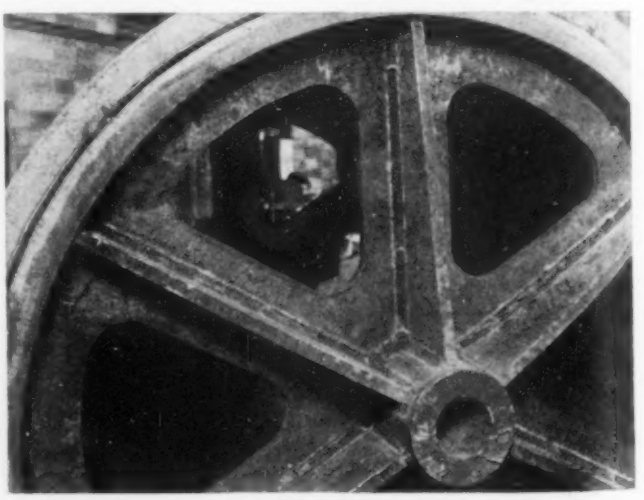


Fig. 8—Shows Close-Up View of Drum End

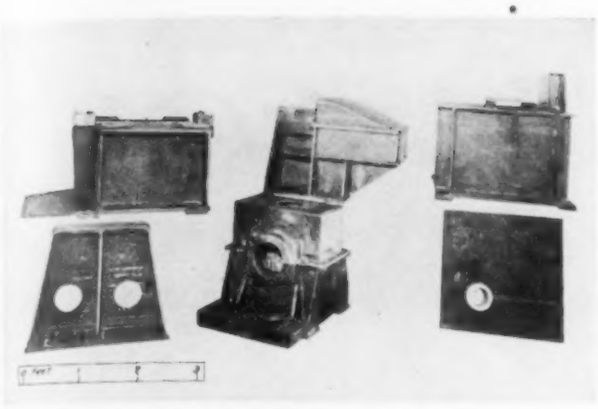


Fig. 9—Gear Cases and Miscellaneous Machinery Supports

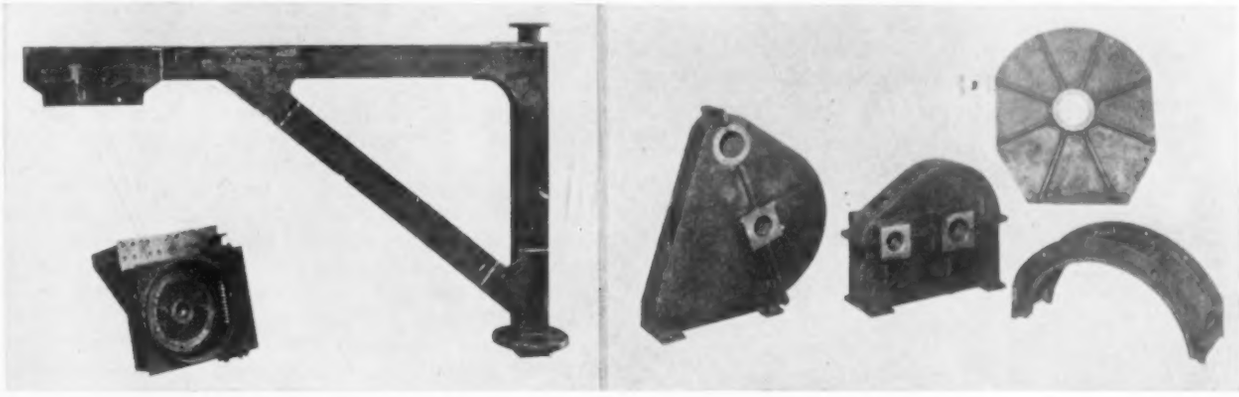
have been made varying from 5% to as high as 40% on parts which could be made of welded steel instead of castings. The 15% saving shown on these cranes is probably a fair average of the possible savings on this type of equipment, and, of course, similar savings could readily be shown for nearly all machinery composed of such parts as bearings, gears, gear cases and cable drums.

Since the saving on the welded parts of a machine does not always have a definite relation to the total cost of the machine, it would not be practical to attempt an estimate of the possible savings if all manufacturers of machinery were to adopt similar methods of arc-welding design. However, the value of machinery manufactured in the United States, where welded parts could be used in place of castings, runs into many millions of dollars annually, and it would be reasonable to say that several millions, at least, would be saved by a more general adoption of welded construction.

CONCLUSIONS

Approximately 80 per cent of those parts which in a design of ten years ago would have been made of cast steel or cast iron, in these cranes were made of welded steel. This fact indicates that the mechanical engineers charged with the responsibility of designing these cranes have come to accept electric welding as a proper and safe method to use in fabricating machinery parts. Also, it speaks volumes for the improvements which have been made during the past ten years in both welding equipment and shop fabricating practice. Arc-welded parts apparently are destined to displace many castings for machinery of this type. Just as the wide flange I-beams and columns are decidedly superior to, and have gradually displaced plate and angle columns and girders to a great extent in the structural steel industry, so these welded parts have gradually demonstrated their economy and superiority over castings.

The achievements in the art of arc welding have given the mechanical engineer a new field in which to employ his ingenuity.



Figs. 10 and 11—Gear Cases and Machinery Supports

ANNUAL MEETING PAPERS

The Papers presented at the Annual Meeting of the American Welding Society not published in the October and November issues will appear in the January, February and March 1940 issues. A number of them are available in the form of a preprint and may be purchased before their appearance in the Journal—Price 50c.

Papers appearing in this Preprint are:

Fatigue Tests of Welded Joints in Structural Plates, by *W. M. Wilson and A. B. Wilder.* Welding of Copper, by *A. P. Young.* Welding Propeller Shaft Tubing for the Automotive Industry, by *Glenn C. Gridley.* Latest Development in Resistance Welding, by *R. T. Gillette.* High Spots in Ship Welding, by *E. D. Debes.* Use of Steel Castings and Rolled Steel Plate in Welded Fabrication, by *H. J. Shiffli and E. L. Krejci.* Designing Construction Machinery for Production by Welding, by *H. C. Hettelsater.* Extension of Fusion Welding in Special Pipe and Pipe Fitting Applications, by *E. Hall Taylor.* Flame-Hardening from the Standpoint of the Commercial Heat-Treater, by *W. G. Hamilton.* Welded Structures Under the Bureau of Yards and Docks, Navy Department, by *Commander C. A. Trexel.* Hard Facing by Fusion Welding, by *T. B. Jefferson.* Flow of Materials in Production Welding, by *Walter W. Petry.* Weld Inspection by Means of Trepanned Plugs, by *Wm. T. Tiffin.* Arc Welding in Controlled Atmospheres, by *G. E. Doan and M. C. Smith.* Cold Rolling Testing of Welded Steel Structures, by *R. L. Dowdell and T. P. Hughes.* The Fabrication of Large Equipment by Welding, by *L. S. McPhee.* Flame-Treating, by *J. H. Zimmerman.* Failure of Aluminum Subjected to Combined Stresses, by *Joseph Marin and R. L. Stanley.* Welded Nozzles and Their Reinforcement, by *F. C. Fantz and W. G. Hooper.* Brazing the Aluminum Alloys, by *G. O. Hoglund.*

Construction of Antarctic Snow Cruiser Nears Completion at Chicago

By G. E. TENNEY*

THE Antarctic "Snow Cruiser," main cog in the government's South Polar claim-laying project is rapidly taking shape at the plant of the Pullman Standard Car Manufacturing Company, Chicago, Illinois. The framework of the 4-wheel monster is fully completed and the application of the outer steel skin is proceeding rapidly.

Design and construction of the 55-foot snow traveler (see Fig. 1), was directed and carried out toward one highly desirable end—to obtain the strongest possible structure with least possible weight. Each two pounds of added weight means a sacrifice of one mile in cruising range. Greatest strength at least weight was obtained by use of high tensile steel structural members, fused into one single homogeneous structure by the modern shielded arc process of electric welding. If conventional riveted construction had been employed, it is estimated that the weight would have been at least 30% greater. Thus, the 16,000 pounds of structural steel would have been increased by approximately 4800 pounds. This excess weight would have cut the cruising range materially from the actual 5000 miles.

Construction of the "Snow Cruiser" by arc welding, (see Fig. 2), consists of fusing together a great number of structural members, cut, formed, fabricated and fitted to the design. The work began with the laying of the 5 longitudinal strength members which are standard 12-inch I-beams, slit lengthwise of the web, vee'd to a taper, then arc welded to provide one-piece members which may be seen in the photo, Fig. 3. This is a unique construction made possible only by welding. From this point, construction became a matter of assembling the structure a part at a time, first tack welding each additional part into the structure until alignment could be checked and then permanently fusing the parts into the whole with full-penetration finishing welds.

Three sizes of electrodes for high tensile steel are being used for the welding. One-eighth-inch size is being used for tack welding and light gage work, $^5/_{32}$ inch for the bottom shell and medium thicknesses, and $^3/_{16}$ inch for the heavy welding. Approximately 550 pounds of electrode will be required for construction.

Utilized so effectively in construction of the "Snow Cruiser," arc welding will also be an extremely important adjunct to the polar vehicle's permanent equipment, for an arc-welding generator, of 200-ampere capacity, fitted for belt drive, will be permanently installed, together with a kit of arc-welding electrodes. The welder will be a necessary tool for the Cruiser's machine shop where it will be used for all sorts of necessary repairs such as the welding of broken or worn machine or structural parts, the fabrication of miscellaneous devices and equipment. With a carbon electrode the welder can be used to cut metal. Indispensable in many ways, the welder may be

* Chicago District Manager, The Lincoln Electric Company.

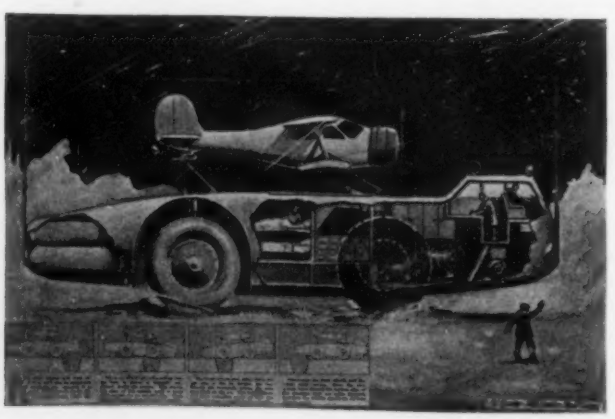


Fig. 1—Artist's Conception of the Antarctic "Snow Cruiser," of the Research Foundation of Armour Institute of Technology, 55 Feet Long, 15 Feet High, Cruising Range 5000 Miles, Top Speed of 30 Miles per Hour on 10-Foot Diameter Tires. Note Plane Carried on Upper Deck. Sketches at Bottom Show How Cruiser Traverses Crevasses

Fig. 2—Arc Welding, Modern Method of Steel Construction, Gives the "Snow Cruiser" Its Long 5000-Mile Cruising Range by Providing a Structure Free of Excess Weight

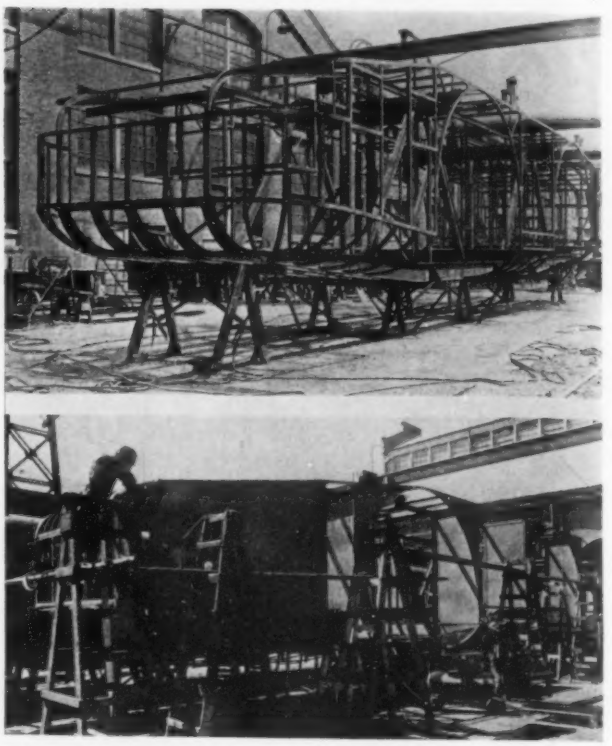


Fig. 3—The "Snow Cruiser" in the Early Stages of Construction Showing Assembly of the Frame. Construction Utilizes 16,000 Pounds of High Tensile Steel

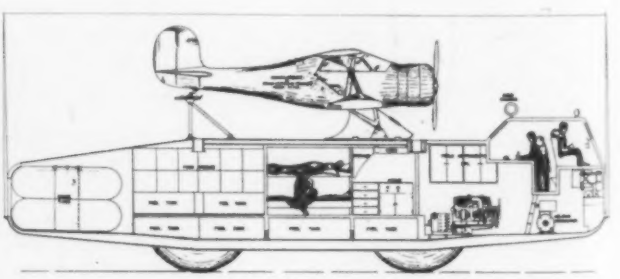
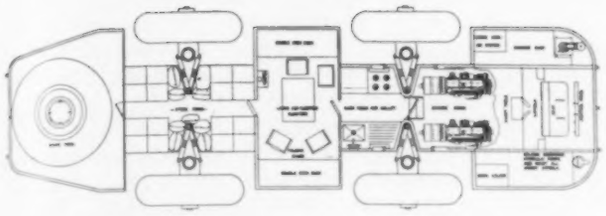


Fig. 4—Elevation Drawing of "Snow Cruiser" Showing Living Quarters, Control Room, Etc.



Over-all length 55 feet 9 inches—Width 19 feet 9 inches

Fig. 5—Arrangement Drawing of "Snow Cruiser"

used for charging batteries and for supplying power to raise or lower the wheels. It may also prove a vital aid in case of emergency since it can supply current for lighting or for operating tools, even starting the diesel engines with which the "Snow Cruiser" is to be equipped.

The "Snow Cruiser" was designed by the staff of the Research Foundation of Armour Institute of Technology, Chicago, as a fundamental research project under the direction of Dr. Thomas C. Poulter, scientific director, who was second in command and senior scientist of the Byrd Antarctic Expedition II. Figures 4 and 5 show arrangement details of the machine.

As unique a self-propelled vehicle as was ever produced by man, the "Snow Cruiser" will carry provisions for one year for a crew of 4 men, will carry a complete scientific laboratory and will make it possible by means of an airplane transported on its top deck, to explore a strip of territory 600 miles wide. Capable of traversing 15-foot crevasses (see at bottom of Fig. 1), propelled by any one or all four of individually driven wheels, the "Snow Cruiser" unit will be able to map and explore in one month more territory than all previous expeditions combined.

The FABRICATION of ROADBUILDING Equipment*

By L. L. BURGER†

IN THE design and manufacture of roadbuilding equipment, several factors require consideration. The customer is interested in securing equipment that is suited to his needs, equipment that will operate economically and yet have a long life of service. Of these requirements, that of service life is perhaps most important of all. Therefore, we must know that all welding and fabricating are properly done, in order to meet the requirements of design and so produce a product that will withstand the rough treatment and abuse to which road machinery is subjected.

Since our products are used all over the world, we must give consideration to the extremes of temperatures and working conditions. A bulldozer which is used in Africa, where the soil may be loose and sandy, must serve the same purpose in our western states where the material to be moved may be a combination of trees, rock and dirt. That same machine must function equally well in the northern states, working in the iron mines.

In order to sell, road machinery must have a reputation for being reliable and dependable. Repair requirements must be low, since in this country the majority of present-day contracts pay a premium on the time consumed in completing a job. Durability is doubly important when considered in connection with machines exported to foreign countries, where neither parts nor suitable equipment are available for making repairs.

Selection of the proper materials is an important factor in the service life of the finished machine. Materials must stand up under heavy loads, and at the same time react favorably to impact shocks and torsion. For economy, we naturally attempt to make use of standard sections wherever possible. However, we cannot afford to sacrifice quality and therefore frequently find it necessary to design our own sections. By so doing, we are usually able to reduce the number of pieces required, and at the same time design such special sections with an eye for the appearance of the finished machine.

A large number of our fabricated parts are of irregular shape and are cut from plates varying in thickness from twelve gage to one and one-quarter inches. For the heavier plates, we have found torch cutting machines the most economical means of fabrication.

Two types of standard make cutting machines are used and in addition we have built one machine of our own design, which is used to bevel the cutting edges of grader blades we are unable to purchase as standard sections. For this work, the grader blade is punched and countersunk and bolted fast to the table, which can be tipped to allow the edge to be burnt off at the desired degree of bevel. The cutting torch travels horizontally above the edge thus held.

On the large machine we have experimented with a series of templates, and have found that the best template is a steel plate representing plate widths of from seven to thirty inches. To this plate is attached a template made of $\frac{1}{8}$ inch x 1 inch strip, so formed that it outlines perfectly the piece to be cut. A magnetic tracer is used in connection with this template, with two or more torches operating at one time, thereby making several duplicate parts at one setting.

This machine has made possible the fabrication of one cutting edge, which in addition to being beveled is also scalloped. Material for this cutting edge has an analysis of 0.90 carbon to 1% manganese. In order to bevel and

* Presented at Annual Meeting, A. W. S., Chicago, Oct. 23 to 27, 1939.
† General Supt., La Plant-Choate Mfg. Co., Inc., Cedar Rapids, Iowa.

scallop this edge, it is first preheated and then placed on a cart built especially for this purpose, this cart having a removable top. The piece is transferred from the ovens to the cutting machine, the top of the cart removed with the cutting edge in place, and slid under the torches. By using a special template, the beveling and scalloping are accomplished in one operation. Immediately after, the piece is again heated and slowly cooled to prevent cracking. Machine torches are a very economical means of fabricating material, and by giving particular attention to layout, it is possible to economize on material and thus reduce scrap to a minimum.

In the design of a new product, or the redesign of an old one, a complete set of drawings is furnished by the engineering department. There is an individual drawing for each part, each sub-assembly, and each complete assembly. Previous to the fabrication of the experimental model, a complete set of templates is made. These templates are made of regular template paper, reinforced, in the case of those for channels and angles, with a 1 inch x 1 inch wood strip. Incidentally, a special layout table, designed by one of our employees, was put into use, in order to hold wear and tear on these templates to a minimum and has proved very successful.

The first machine in this new product is fabricated complete and built in the experimental department. The machine is then tested, corrections or changes made, and the drawings and templates changed accordingly. Jigs and fixtures are provided, and the machine is ready for the manufacturing department.

Upon release of the machine for production, one model only is built. This gives us the opportunity to study the product in each manufacturing department and to make any changes necessary in the jigs and templates previous to the time the model is put into actual production. We have found this to be the most economical method of producing a new model machine.

In the welding of our product, one man is responsible for all welding. It is his duty to work out the proper welding procedure for each product. He must see that the parts are properly fabricated, that the proper type of welding rod is used and that the proper size of that rod is used at the correct heat. In this connection a record is made of each operation and furnished the foreman so that he may know that each procedure is followed. Each operator is assigned a steel number stamp with which he must identify all of his work. This is required so that in case we find an inferior weld, the operator can be immediately shown what happened and why, and be instructed as to the proper procedure to prevent a reoccurrence. This practice also enables us to check field failures should they occur.

A large number of parts are machined previous to welding. As an illustration, our tamper housing consists of a tube four inches in diameter by forty-eight inches in length. To each end of this tube is welded a twelve-inch disk of mild steel, one-half inch thick. This part is then machined for the bearing seat on each end, the seat being held to within 0.001 and the over-all length being held to less than 0.005. After machining, it is placed in the tamper head and securely welded in place. By following the proper procedure in welding, no distortion results.

Another illustration of machining before welding is that of a bronze bearing assembly used on a scraper. The bronze bearing stock is first turned, then pressed into a seamless tubing sleeve. It is then machined to within 0.004 on the I.D. and then spotted in place in the assembly jig and tack welded. When removed from the jig, a three section split taper plug is placed inside the bearing and drawn in tight by a taper pin. The part is then welded and the plug left until the section is cool before it is removed. Distortion in this case is less than 0.010 and must be held at a minimum since a shaft is placed through this and a similar bearing.

A cast-iron bushing is used in a manner corresponding to the bronze bearing mentioned before. Here again, the bushing is pressed into a sleeve made from seamless tubing and the assembly is then welded in place. In this case, the I.D. is held to within $^1/_{64}$ inch and the assembly is welded in place with less than 0.005 distortion. Two of these bearings are placed 8 inches apart and an all welded trunnion must fit between them.

The majority of our welding consists of welding mild steel, commercial steel castings and the minor alloys. We have some welding of 1045 heat-treated castings to mild steel, and also weld 1045 heat-treated shafting to mild steel. The thickness of the steel is from 12 gage to $1^1/_4$ inch and the material consists of channels, angles and plates. In assembling, welding seams vary from a few inches to twelve feet. For our long seams and heavy sections we use a weld metal of high ductility in order to reduce the locked up stresses. For our fixed bearing points, we use a weld metal which has a high yield. We require our weld rods to test a minimum of 50 foot pounds Izod at minus 25° F. or plus 70° F., in order to withstand the high impact shocks under varying climatic conditions to which the product will be subjected.

A majority of our products are assembled and welded in special fixtures. These fixtures are designed and made in our shop in a department especially set up for the purpose. Since the greater share of our machines mount on tractors, drill jigs are necessary. These jigs are also of all-welded construction. We make a large number of our small parts into sub-assemblies, for which fixtures are also provided. All fixtures are so designed that everything possible is put into place, thus insuring speed, economy and quality of weld.

We have been welding for several years, but when our designs were first changed, we in the shop were a little doubtful as to how the equipment that had been used for the building of riveted equipment could be used in the process of welded construction. Our machine shop always had most of the work due to the large number of castings used. With the advent of welding, castings were eliminated wherever welded assemblies proved more economical and as a result forming, bending and welding operations increased. We soon learned to adapt our equipment to the new demands and to the best advantage; the machine shop was reduced to one-half of its former size, and the operations turned over to forming, bending and punching parts to be welded.

With our present type of welded construction, we have no reluctance in making minor improvements. We need not worry about making pattern changes, and awaiting delivery of new castings. The change can be made now, today. Even major programs of redesign or entirely new designs involve little expense in templates, tools, etc., in contrast to former methods.

By utilizing welded design and construction, we have reduced our capital charges per unit of production and have increased our productive capacity 25%. Our business has materially increased in the past few years, yet our investment in equipment and buildings has been held to a minimum. Our write-offs for obsolescence of tools and equipment has been considerably reduced. It appears to us that the capital requirements of a business adopting welding wherever possible will be much lower than those which fail to use the modern method of joining metals—Welding.

WELDING IN THE MANUFACTURE of Valves for High Pressures and Temperatures*

By W. F. CRAWFORD† and L. H. CARR‡

THIS paper is concerned with the use of welding in the construction of forged and cast steel valves for high pressures and elevated temperatures. There is relatively little published information on this subject, although the uses of welding in power and process piping construction have been widely publicized.[1] Since the introduction of the electric arc covered electrode, and the development of oxyacetylene hard surfacing processes, welding has played an important part in improving the design of many types of valves for widely different kinds of service.

The first use of welding in pipe fabrication for high pressure and temperature service seems to have been the Sargol flanged and seal welded joint developed by Sargent & Lundy, Consulting Engineers, and Olaf E. Oleson, then president of the Edward company, in 1910. This joint, without modification, is still extensively used.

Before the World War, repair of steel castings by oxyacetylene welding was successfully used, but the widespread application of welding to pressure casting repair has been fully developed only since the advent of the covered electrode and its resultant ductile and impurity-free weld metal.

For over 25 years valve designers have used welding successfully for construction of external valve parts such as brackets, extension stems, gear covers and boxes, pinion supports and valve suspension and supporting structures. Fabrications of this type have been widely accepted and can be considered as routine valve construction.

The American Society for Testing Materials and collaborating societies, recognizing the widespread use of welding in power plant, refinery and technological process piping, have identified a number of materials for high pressure-temperature service. These materials, with occasional minor modifications in analysis, are suitable for welded valve construction. In Table 1 are chemical and physical specifications for the more widely used materials for bodies and internal parts. Sufficient design and metallurgical data have been published to permit any competent welding organization to fabricate successfully any of these materials. While requirements for design, welding technique, heat-treatment and machining must be thoroughly considered, the development of modern electrodes and welding equipment greatly facilitate present day fabrication by welding. Manufacturing economics, rather than metallurgical considerations, determine the use of welded construction in most valve designs.

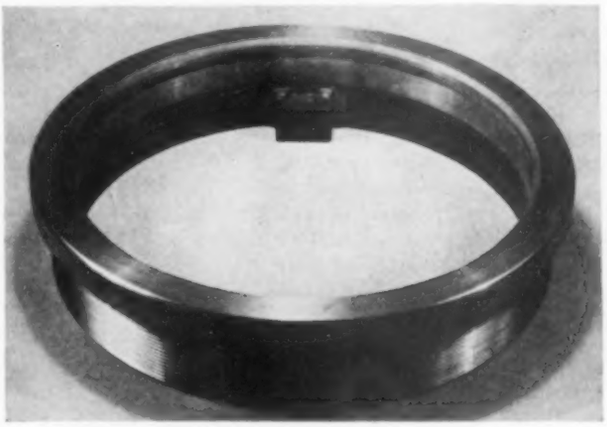


Fig. 2—13.0% Chromium Stainless Steel Valve Seat with Welded Wrench Lugs

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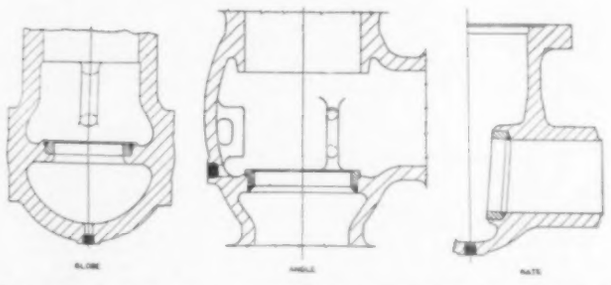

Fig. 1—Typical Designs for Welded-In, Hard-Surfaced Valve Seats

VALVE DETAILS UTILIZING MODERN WELDING

At the present time, welding is utilized in the following details of valve design and construction:

Welding Ends

Manufacturers of steel valves regularly design gate, globe, plug and other types of valves with ends for welding, instead of flanging, into pressure piping systems. Completely welded power plant piping systems have been in use for more than 12 years.

Welded-In or Integral Hard Surfaced Seats

As early as 1929 seat rings of both gate and globe valves were welded into valve bodies in order to eliminate leakage between seats and bodies, due to poor thread fit, variations in operating temperature, faulty design, or different coefficients of expansion between seat and valve body materials. Figure 1 show typical construction of

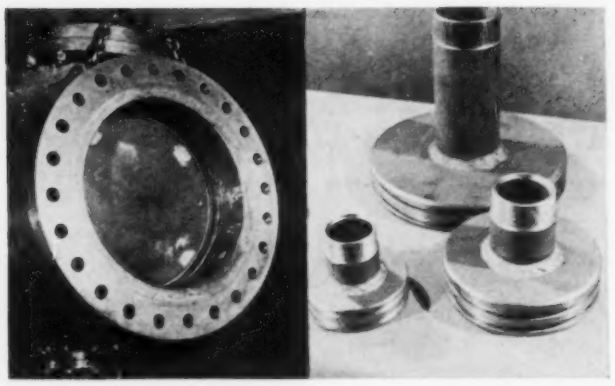

Fig. 3—(Left)—24-Inch Bleeder Line Valve with Rolled Steel, Stellited Disk. Note That Valve Seat Is Welded to Body. (Right) Valve Pistons with Forged Steel Bases and Seamless Steel Tubes Fabricated by Welding

globe, angle and gate valves. Welded-in or integral hard surfaced seats are in use in valves from sizes $^1/_8$ inch to 24 inches. This construction involves increased cost due to additional preheating, heat-treating, and machining operations which are often necessary. Use of this construction is likely to increase due to rapid advance in hard surfacing technique, and to more effective methods of eliminating foreign matter during construction and initial operation of piping systems.

Seat Lugs

Screwed in seats of forged steel, with welded wrench lugs or spiders, sometimes tend to reduce manufacturing costs, especially when more expensive milling or slotting operations can be eliminated. Seats of carbon or low alloy steels with hard surfaced seat faces, 13 per cent chromium steels, 18–8 and 26–12 chromium nickel steels, can be successfully fabricated with welded wrench lugs. Routine manufacturing procedure should include correct heat-treatment after welding. In welding the higher alloys a preheating operation is often desirable. Figure 2 shows a typical globe valve seat with welded lugs.

Fabricated Bodies

Valve designs have been developed which utilize fabricated hollow bodies. These designs range from castings or forgings in halves, for fabrication together by butt or resistance welding, to welded designs utilizing standard seamless pipe and commercial flanges for bodies and bonnets. Drop forgings, utilizing welded-on flanges, are widely used. A section of this paper is devoted to designs of this type.

Lockwelds

Lockwelding mating internal valve parts, such as valve disks and disk nuts, is employed as a substitute for set screws, washers or locknuts subject to elevated temperatures. Lockwelds are used for securing screwed parts which might otherwise come loose. While effective and economical, they present certain problems. In valve construction, when used on air hardening steels, the material adjacent to the lock or spot weld may become quite hard, due to the high cooling rates inherent in such small weld deposits. The weld deposits themselves may be sufficiently diluted by the base materials to be air hardening. When this effect is combined with service vibration, and repeated forces due to heating and cooling, the welds are quite sorely stressed. Sound lockweld design usually means the largest weld that can be conveniently severed to separate parts for repairs, and that will develop good ductility and minimum distortion.

Fabricated Valve Disks

Disks of rolled steel, with reinforcing webs and braces of welded sections, have been adroitly used in swing check, bleeder line and gate valves. While design practice can follow routine welding procedure, it is advisable that constructions of this type be thoroughly heat-treated to prevent future distortion due to stresses caused by welding. Figure 3 shows the inlet side of a 24-inch bleeder line valve utilizing a rolled steel plate disk with Stellited seating surface. Note that the Stellited valve seat is welded to the body.

Pistons

Figure 3 shows several sizes of fabricated pistons for check valves. These parts, which are screwed and lockwelded to valve disks, are made of drop forgings and seamless steel tubing. This design replaced castings which involved intricate foundry problems. Thousands of these parts have been fabricated, effecting considerable saving in cost over the former castings. Single pass

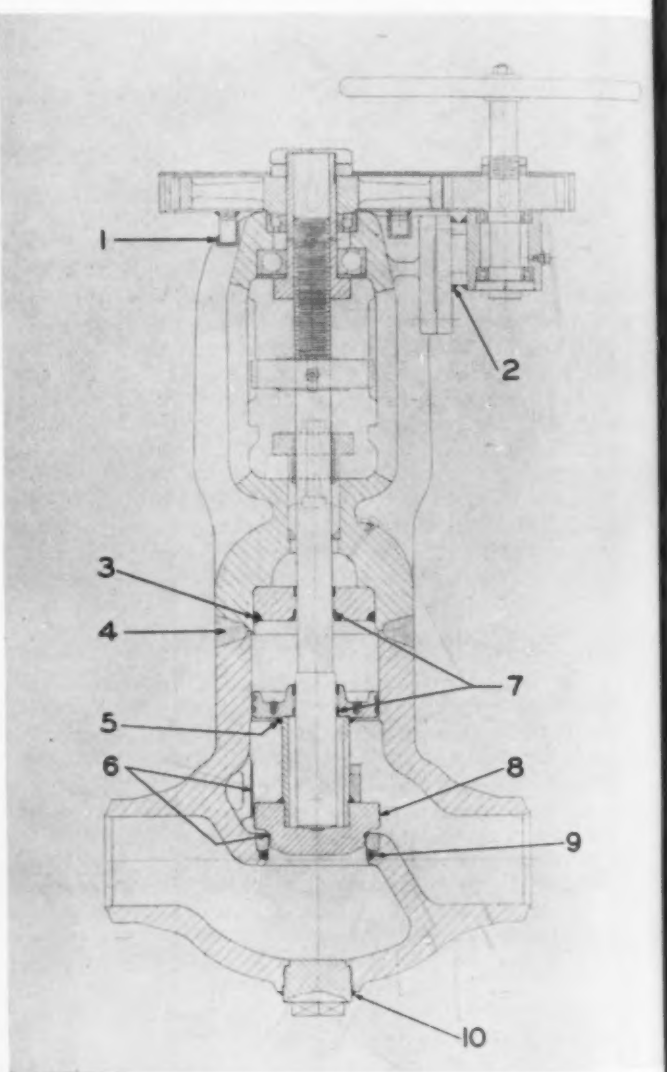

Fig. 4—Cast Alloy Steel Non-Return Valve Showing Uses of Welding

1. Electric Welded Gear Housing
2. Electric Welded Pinion Bracket
3. Electric Welded Stem Guide and Bonnet Back-Seat
4. Electric Welded Body-Bonnet Joint
5. Piston Assembly Fabricated by Welding
6. Oxyacetylene Hard Surfaced Seat and Disk Seating Surfaces and Guide Ribs
7. Electric Deposited Hard Faced Bearing Surfaces
8. Hard Faced or Flame Hardened Disk Guiding Surface
9. Welded-In Seat
10. Pressure - Seal - Welded Hand Hole Plug

welding with large diameter electrodes is regularly employed. Possibility of distortion of these parts in service is precluded by annealing or normalizing subsequent to welding. Both carbon and alloy steels are utilized in this construction.

Hard Surfaced Bushings and Bearings

Hard surfacing materials are widely employed for valve bearing surfaces which must withstand abrasion and impact in high pressure and elevated temperature service. Arrows 6 and 7 on Fig. 4 show some applications. Hard surfacing materials containing chromium, boron, or tungsten, which can be deposited by the electric arc process, are most successful. Where surfaces require exceptionally fine polished finishes, Cobalt Chromium Tungsten No. 1 or 6 or Nickel Chromium Boron No. 6 have been used. Galling and seizing characteristics of the hard surfacing material and mating parts require study. Welded bearing surfaces often must withstand tremendous compression and repeated impact. Figure 13 indicates the effect of temperature on hardness. This characteristic must be carefully considered when adopting hard surfacing materials for valve service

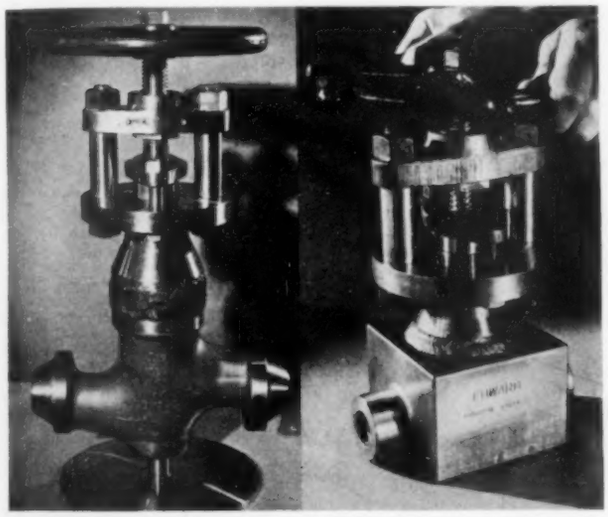

Fig. 5—Forged Steel Globe Valves with Welded-In Stellited Seats and Disks and Welded Bonnets. Left Hand Valve for 1500 Lb. s.p. 950° F, Right-Hand Alloy Steel Valve for 3000 Lb. 1200° F, Has Screwed and Welded Bonnet

in elevated temperatures. Flame hardening can be advantageously utilized for surfaces subject to wear when valve operating temperatures do not exceed 650° F.

Welded Valve Bonnets

Perhaps the most interesting welding development in the valve industry in recent years has been the installation of valves having welded, instead of flanged, bonnets. While the design has been used for some years in the production division of the petroleum industry, its use in elevated temperature service is relatively new. The development is an outstanding tribute to the efficacy of welding in the pressure field and the designs would be far less efficient and economical if it were not for the utilization of welding ends, welded-in seats, and hard surfacing materials. Up to the present, the most numerous applications have been with gate valves, although non-return and globe valve designs are shown in Figs. 4 and 5. In Figs. 4 and 5 (left) the welded joint is under full internal pressure and conservative procedure includes thorough stress relieving after welding. In many cases X-ray or gamma ray examination is considered essential. In Fig. 5 (right) the design utilizes a threaded

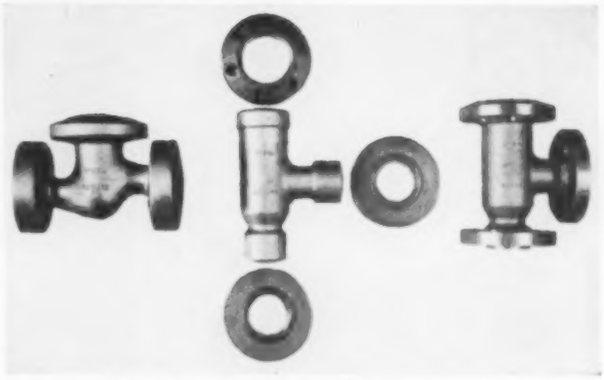

Fig. 6 (Left)—1 Inch 1500 Lb. s.p. Forged Steel Globe Valve Body with Integral Flanges. (Center) 1½ Inch 600 Lb. s.p. Angle Valve Body with Forged Flanges. (Right) Completed Assembly After Screwing on and Welding Flanges

and welded bonnet connection. These valves eliminate leakage due to faulty gaskets or to creep or relaxation of bonnet bolting. It is mandatory that piping systems employing this construction be thoroughly cleaned before initial operation because damage to the valve seating surfaces requires costly repairs. Large valves with welded bonnets sometimes have small handholes, as shown by arrow 10 in Fig. 4, for emergency examination of seating surfaces. In the design illustrated, the plug has a pressure tight ground joint, thread, and small seal weld. The weld must be ground or chipped away before removal of the plug.

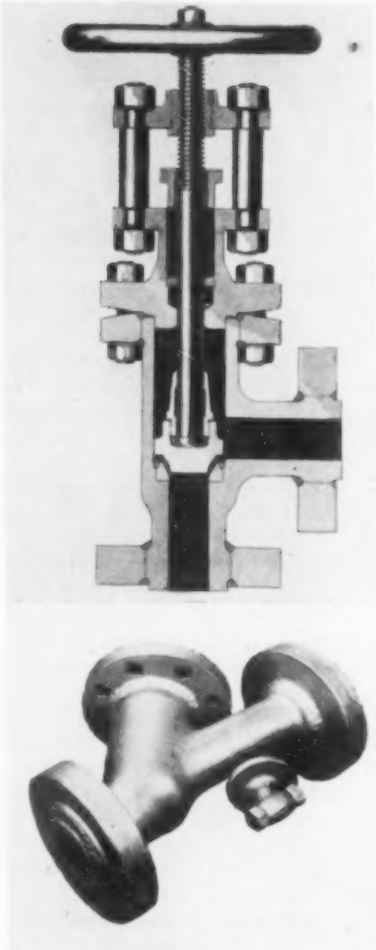

Fig. 7 (Top)—Valve Cross Section Showing Details of Body Having Welded-In Seat and Screwed and Welded Flanges. (Bottom) Comparative Size of Smallest and Largest Edward Drop Forged Valves with Welded Flanges. Picture Taken After Welding and Heat Treatment

Fig. 8—Test Blocks for Determining Hardening Effects, Preheating Temperatures, and Electrode Characteristics. Note Cracks in Right-Hand Block

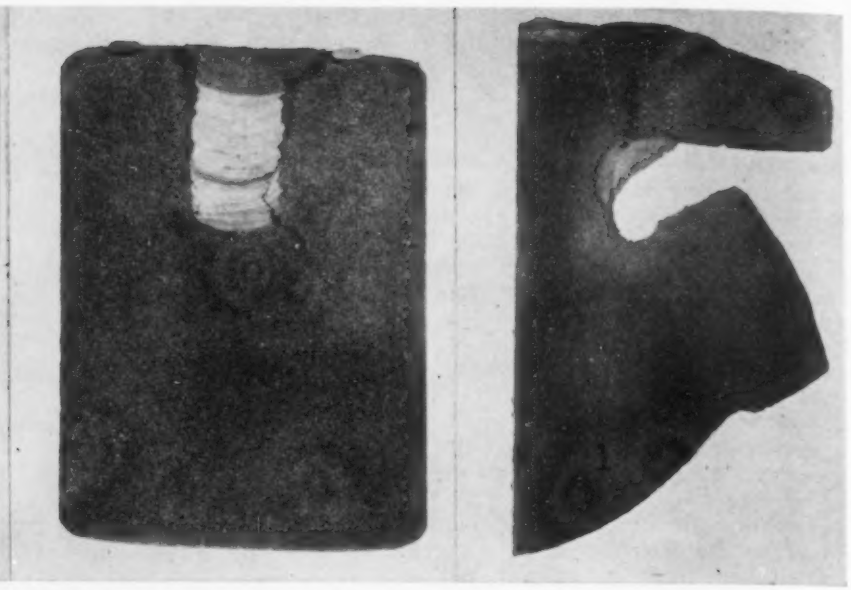

Fig. 9—Vickers Hardness Tests on Small Forged Steel Valve Body with Screwed and Welded Flange

Valve Body Flanges of Screwed and Welded Construction

A valve design of screwed and welded construction first developed in 1926 has effected economy in valve manufacture and resulted in the use of tens of thousands of these valves in many different industries. Interesting testimony to the soundness of welded construction is found in widespread use of this construction in steam power plants in the United States operating above 500 lb pressure, as well as in many lower pressure plants. As welded power piping systems have come into more general use, valve body forgings of this type have been found to be particularly adapted to butt or socket welding.

The left-hand forging in Fig. 6 illustrates a 1-inch drop forged steel valve body for 1500-lb. service with three integral flanges. The unique contour obviously requires an expensive set of dies having multiple impressions. The severe reversal of fiber flow taxes the ingenuity of forging die designers and metallurgists. Reheating may be necessary to avoid burning of the steel. Large draft angle is required because of the deep impression. Difficult handling is unavoidable in changing from roughing to finishing impressions. Die maintenance is considerable. Rejections due to warpage and surface flaws may be numerous if the forge shop hammer crew is inexperienced. The center and right-hand forgings in Fig. 6 show a $1^1/_2$-inch blow-off valve body for 600-lb. pressure of a design fabricated by welding. Top of Fig. 7 shows in cross section details of bonnet and end flange construction. It will be noted that the welds are entirely outside the fluid pressure area. Some years ago this tended to overcome prejudice against welding; today, if the production runs are large enough and suitable welding equipment is utilized, the threaded construction can be eliminated and the flange affixed by welding only.

Lengthy discussion of the metallurgical requirements of materials for valves of this type is unnecessary. The requirements are, in the main, similar to those of much of the rest of the equipment found in power plants, such as piping, boilers and turbine equipment. Present day practice prefers that valve parts approximate the rest of the piping systems in metallurgical properties. Table 2 is included to show the typical chemical and physical properties of one of the most popular current analyses. Figures are given for cast and forged material and the comparable deposited weld metal and joint. The standard 0.505-inch test specimens were taken perpendicular to a butt-weld joint, so that they included both parent and weld metal along the gage length. It will be noted that certain properties are lower than the comparable cast and forged material data, but this is to be expected with lower carbon content.

Valves with welded flanges can be made of any of the materials shown in Table 1. Constructions of this type, having residual stresses caused by welding in opposing locations, necessarily require stringent metallurgical inspection and process control. Development of new designs and use of new materials must follow thorough testing routine. Aside from the essential laboratory tests for tensile, bend, impact, rotation and pulsation fatigue, hardness, abrasion, creep, thermal expansion, microstructure, density, radiographic examination, machinability, corro-

Fig. 10—Production Equipment with Variable Speed Revolving Fixture for Welding Flanges

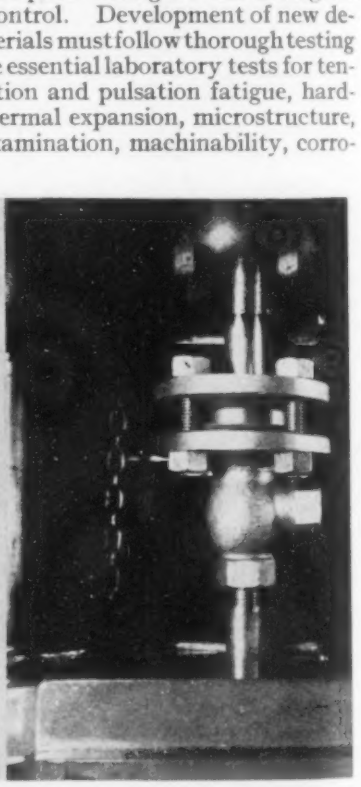

Fig. 11—Amsler Pulsation Fatigue Test on Completed Valve Body Duplicating Actual Operation. Tests Also Made at Elevated Temperatures

Table 1—The More Widely Used Valve Materials

Material	A. S. T. M. Specification	C	Mn	P	S	Si	Cr	Ni	Mo
		Analysis (Maximum Unless Range Given)							
Carbon Steel	A 216-39T WCB	0.35	0.70	0.05	0.06	0.50			
	A 105-36	0.35	0.40–0.80	0.05	0.05				
Carbon Molybdenum Steel	A 217-39T WC1	0.30	0.70	0.05	0.06	0.50			0.40–0.60
	A 182-39 F1	0.35	0.30–0.80	0.04	0.05	0.20–0.50			0.40–0.60
Chromium Nickel Molybdenum	A 217-39T WC4	0.20–0.30	0.40–0.70	0.05	0.06	0.25–0.55	0.40–0.70	0.75–1.05	0.30–0.45
	A 182-39 F4	0.35–0.45	0.50–0.80	0.04	0.05		0.50–0.80	1.50–2.00	0.30–0.40
5% Chromium Steel	A 157-39 C5	0.15–0.35	1.00	0.05	0.06	0.20–1.50	4.00–6.50		0.40–0.65
	A 182-39 F5	0.15–0.25	0.30–0.50	0.03	0.03	0.50	4.0–6.0		0.45–0.65
13% Chromium Steel	A 157-39 C6	0.15	0.75	0.05	0.05	1.00	11.5–13.5	0.80	0.50
	A 182-39 F6	0.12	0.50	0.03	0.03	0.50	11.5–13.5		
18-8 Cr-Ni Steel	A 157-39 C9	0.15	1.00	0.05	0.05	2.00	18.00 Min.	8.00 Min.	
	A 182-39 F8	0.07	0.50	0.03	0.03	0.20–0.40	17.0–20.0	7.00–10.00	

Physical Properties Minimum

Material	A. S. T. M. Specification	Tensile Strength	Yield Point	Elongation	Reduction of Area	Valve Use
Carbon Steel	A 216-39T WCB	70,000	36,000	22.0	35.0	Bodies
	A 105-36	70,000	36,000	22.0	30.0	
Carbon Molybdenum Steel	A 217-39T WC1	70,000	45,000	22.0	35.0	Bodies
	A 182-39 F1	70,000	45,000	25.0	35.0	
Chromium Nickel Molybdenum	A 217-39T WC4	80,000	55,000	20.0	35.0	Bodies
	A 182-39 F4	90,000	70,000	18.0	50.0	
5% Chromium Steel	A 157-39 C5	100,000	65,000	18.0	30.0	Bodies
	A 182-39 F5	90,000	65,000	22.0	50.0	
13% Chromium Steel	A 157-39 C6	85,000	55,000	20.0	40.0	Bodies and Parts
	A 182-39 F6	85,000	55,000	25.0	60.0	
18-8 Cr-Ni Steel	A 157-39 C9	70,000	30,000	35.0	40.0	Bodies and Parts
	A 182-39 F8	75,000	30,000	45.0	50.0	

sion and scaling resistance, another simple but effective test may be employed. Figure 8 shows a test block for determining electrode characteristics, air hardening tendencies, and general availability of new analyses. In one case the drilled hole in a 4 x 4 x 6 inch billet has been welded satisfactorily. In the other, cracks due to air hardening characteristics and weld shrinkage are noted. Normally preheating of the parts will eliminate such defects. This deep hole test is also a good indication of a welding operator's ability.

Figure 9 cross sections a valve body having large weld mass in relation to forging mass. In this case two passes of weld metal are used on the top of flange and one pass on the under side. The following table shows average Vickers Brinell figures for this body fabricated from carbon-molybdenum (0.50%) material in conformance with A. S. T. M. A182-39 grade Fl.

(a) Single pass weld no preheat 180 to 310 Bhn.
(b) Single pass weld 400° F. preheat 180 to 250 Bhn.
(c) Multiple pass weld no preheat 150 to 223 Bhn.
(d) Multiplepass weld 400° F. preheat 140 to 200 Bhn.

Tests of this nature help to establish welding procedure and to make sure that high speed welding operations with heavy electrodes will not injure the parts before heat-treatment. Thorough normalizing follows welding. Valve constructions of this type are welded in variable speed rotating fixtures as shown in Fig. 10. The number of passes and sequence of operation depend upon mass, location of weld, and future machining operations. After heat-treatment, the end flange and bonnet gasket surfaces which require a fine machine tool finish are frequently machined from deposited weld metal. This operation incidentally is a check on weld quality.

Figure 11 illustrates a unique test to check welded assemblies. Complete valve bodies can be subjected to a pulsation fatigue test at varying temperatures and loads. In the test shown a pulsating maximum load of 18,000 psi was repeatedly applied more than one million times without causing failure. Further increase in load eventually caused failure in other parts of the valve construction. The weld remained intact.

The use of valve constructions of this nature is dependent upon the number of pieces required, the materials used, the ratio of flanged end and welding end valves sold, and the comparative forging and welding cost figures. The principle of valve body parts fabricated by welding has long since been proved fundamentally sound. Forging quality improved by fabricated designs, and also valve users can obtain valves with special dimensions or flanges at greatly reduced cost.

Hard Surfaced Seats and Disks

Records available to the authors indicate that the first hard surfaced steam valve job was completed in 1926, and that the extensive use of Cobalt Chromium Tungsten for hard surfacing valve parts commenced about 1930. The interested investigator has at his command A. W. S. papers[2] and technical information.

Seating material in valves must withstand erosion taking place at high temperatures due both to high velocity of the passing fluid and to any foreign particles that may be entrained. Hence, the material must have a combination of wear resistance at elevated temperature, corrosion and oxidation resistance and a uniformity of structure so that selective erosion will not take place. Tests have shown, for example, that sintered Tungsten Carbide bonded with nickel is eroded by steam jets in spite of its extreme hardness. The material used must also be capable of being finished to a smooth surface to form a pressure-tight joint. If the seating surfaces are to be made of a weld deposit, they must be of such nature that they will stand the high pressures exerted in closing a valve and the changes in temperature which take place when a high temperature valve is opened and closed.

Material of this type must necessarily be handled with

a great deal of care because its properties are vastly different from the ordinary structural steels with which most engineers are familiar. This difference in properties is indicated by the results of physical tests which have been made on an alloy containing Cobalt, 55.00% minimum; Chromium, 27.00% to 33.00%; Tungsten, 3.00% to 6.00%; remaining elements, 7.50% maximum, in order to uncover any possible weaknesses it might have as a valve seat facing material. A series of tensile and fatigue tests (Fig. 12) were made with three types of test specimens at room temperature and at 1000° F. One set of specimens was made from solid Cobalt Chromium Tungsten, remelted from the original cast welding rod. A second set consisted of tensile test bars

Table 2—Properties of Carbon Molybdenum Steels

		Cast	Forged	Weld Deposit
Chemical Analysis	C	0.27	0.29	0.13
	Mn	0.75	0.67	0.60
	P	0.030	0.018	0.018
	S	0.021	0.022	0.040
	Si	0.40	0.21	0.34
	Mo	0.42	0.50	0.55
Tensile Strength	70° F.	82,000	89,000	72,000
	750° F.	73,000	80,000	73,000
	850° F.	65,000	75,000	66,000
	1000° F.	50,000	55,000	54,000
Yield Strength .2% Set	70° F.	61,000	65,000	55,000
	750° F.	39,000	45,000	40,000
	850° F.	35,000	42,000	36,000
	1000° F.	32,000	38,000	33,000
Elongation in 2 inches %	70° F.	26.0	30.0	23.0
	750° F.	29.0	31.0	19.0
	850° F.	31.0	31.0	18.0
	1000° F.	37.0	35.0	20.0
Reduction of Area %	70° F.	46.0	64.0	62.0
	750° F.	50.0	75.0	35.0
	850° F.	53.0	75.0	36.0
	1000° F.	63.0	79.0	60.0
Charpy Impact Ft.-Lb.	70° F.	25.0	30.0	40.0
	750° F.	23.0	25.0	18.0
	850° F.	20.0	19.0	17.0
	1000° F.	17.0	16.0	15.0
Brinell Hardness	70° F.	175	210	155
	750° F.	180	190	150
	850° F.	170	175	145
	1000° F.	130	130	125
Fatigue Limit, Lb. (R. R. Moore)		40,000	37,400	30,000
Creep Strength 800° F.		24,000	23,000	22,000
1000° F. (0.01% in 1000 hours)		5,000	5,000	4,500
Coef. of Thermal Expansion Average 70 to 1000° F.		8.11×10^{-6}	8.10×10^{-6}	8.00×10^{-6}

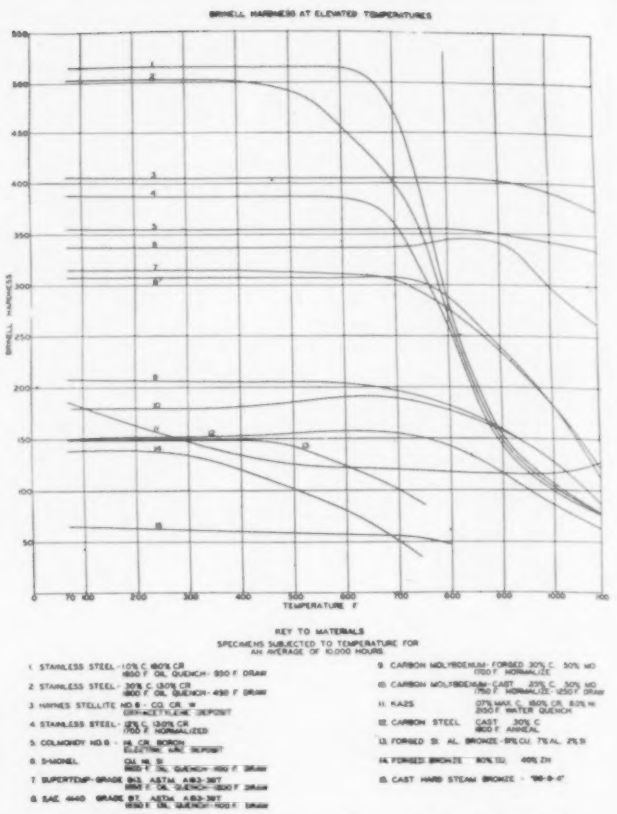
BRINELL HARDNESS AT ELEVATED TEMPERATURES
BRINELL HARDNESS
TEMPERATURE F
KEY TO MATERIALS
SPECIMENS SUBJECTED TO TEMPERATURE FOR AN AVERAGE OF 10,000 HOURS

Fig. 13—The Effect of Temperature on Brinell Hardness

which were machined to a diameter of 0.360 inch along the gage length and then hard surfaced with sufficient alloy so that they could be finished to the standard 0.505 inch diameter test bars. A third set was machined from bars of forged carbon molybdenum steel which were butt-welded by means of a deposit of Cobalt Chromium Tungsten. These bars were so machined that the weld deposit occurred in the center of the 2-inch gage length. Thus, a tensile stress upon the specimen tested the strength of two bonds between the weld and the base material. Tensile tests with the third type of specimens were made at 70 and 1000° F. and tensile fatigue tests were made at the same temperatures by subjecting specimens to a load which pulsated between a minimum load of 5000 psi and various maximum values. In this manner a limiting stress was obtained which did not cause failure within one million cycles of stress repetition

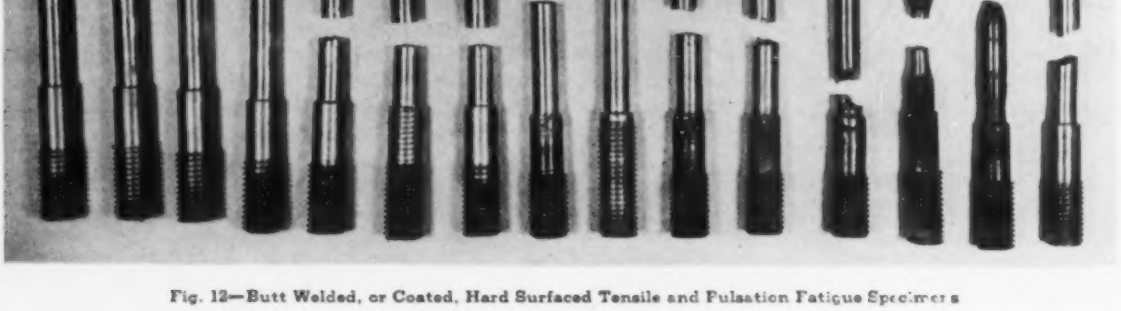

Fig. 12—Butt Welded, or Coated, Hard Surfaced Tensile and Pulsation Fatigue Specimens

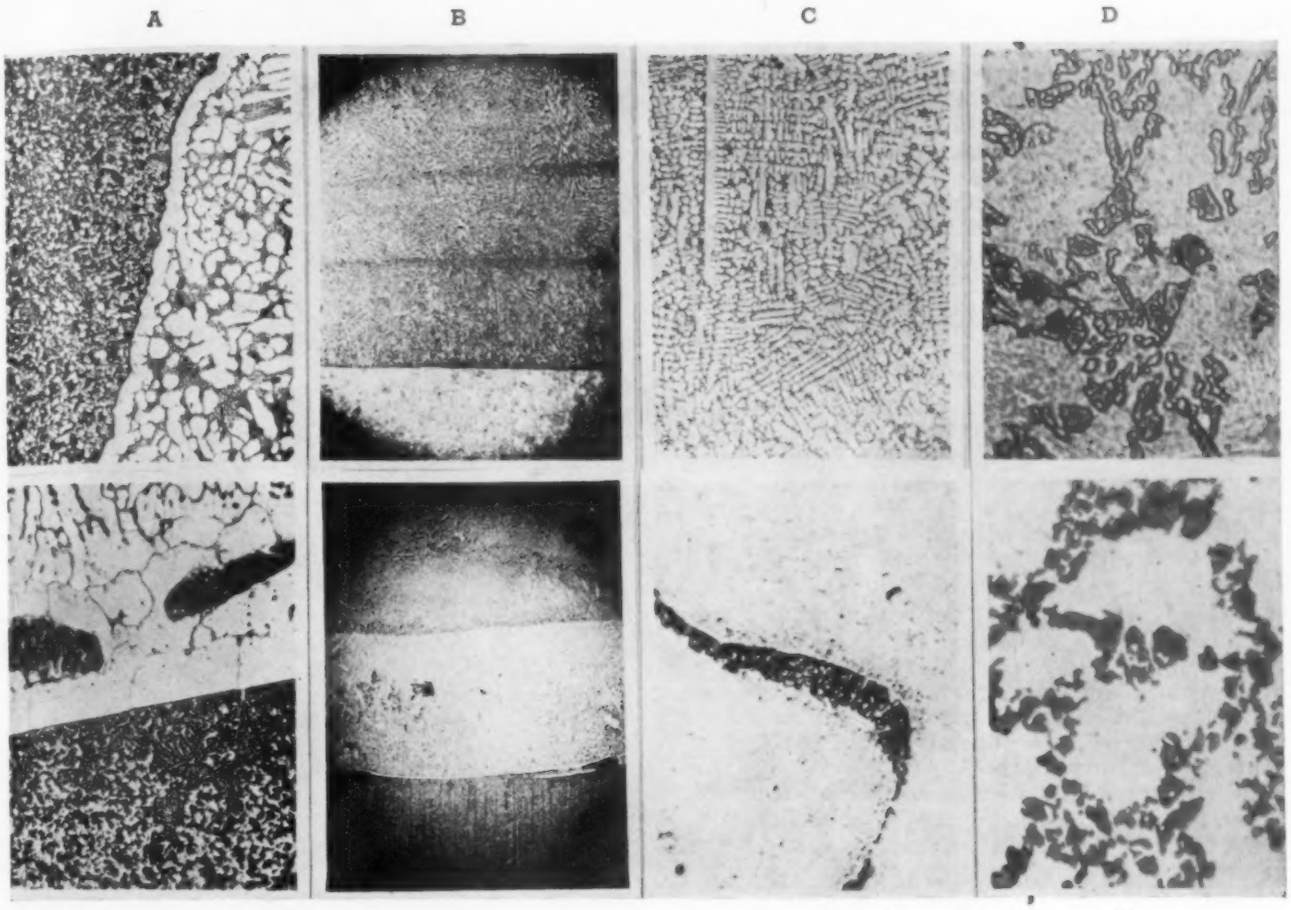

Fig. 14

A. Junction Between Co Cr W Deposit and Rough Machined Forged Carbon Molybdenum Steel. 100 X
B. Three Properly Deposited Layers of Co Cr W on Carbon Steel. 10 X
C. Junction Between First and Second Layers of Co Cr W Shown in Fig. B. 100 X
D. Normal Structure of Co Cr W. 1500 X. 550 Vickers Brinell Hardness
E. Junction Between Carbon Molybdenum Steel and Co Cr W Deposit Improperly Applied. Highly Diluted with Iron. 100 X
F. Improperly Applied Deposit with Two Additional Layers. 10 X
G. Co Cr W Highly Diluted with Base Steel. 1500 X. 200 Vickers Brinell Hardness
H. Second Layer of Co Cr W with Less Dilution. 1500 X. 450 Vickers Brinell Hardness

and the position of the fractures gave an indication as to the relative fatigue strength of the Cobalt Chromium Tungsten, the base material, and the bonds between them. The second set of tensile bars were pulled at room temperature and 1000° F. in order to determine the amount of deformation such a deposit would withstand, the tensile strength of such a bimetallic bar, and whether there was a tendency for the hard surface material to spall upon fracture. The tensile strength of the coating itself was obtained by reducing the diameter of the butt-welded type test bars previously described so that the fracture was bound to occur in the weld. The fatigue strength of the alloy was obtained with solid bars of 0.130 inch diameter in a 10,000 reversals per minute rotating cantilever beam type of fatigue testing machine. These results are tabulated in Table 3.

Table 3—Physical Tests of Cobalt, Chromium, Tungsten Alloy Deposits

Type of Test Bar	Solid Bars Deposited by Torch	Coated Bars, 1/16-Inch Layer on Forged 1/2% Molybdenum Steel	Forged 1/2% Mo Steel Bars Joined by Deposit
Tensile			
70° F.	87,500 psi	81,000 psi	76,500 psi
1000° F.	80,500 psi	74,500 psi	Fracture at junction 56,000 psi Fracture in steel
Fatigue Limit			
70° F.	35,000 psi		5,000 to 40,000 psi Fracture in deposit
1000° F.			5,000 to 35,000 psi Fracture in steel

Such tests show that the alloy has a tensile strength equal or slightly in excess of commonly used base materials, but its fracture is of an entirely different type. It tends to break off quite sharply with very little permanent elongation and practically no reduction in area. At temperatures of 1000° F. the tensile strength exhibits little change, which is quite in contrast to the great loss in strength encountered in most steels at this temperature. At room temperature the fatigue strength is somewhat lower than in ordinary steels as is shown in both the results of the rotating beam test and in the fact that in the tensile fatigue test the fractures took place directly through the center of the Cobalt Chromium Tungsten deposit. At 1000° F. this condition is

reversed and the fractures took place in the base material at only slightly lower maximum values of stress. The coated test bars showed a uniform elastic elongation up to approximately half their tensile strength, which is in the neighborhood of the yield strength of the base material. This shows that such bimetallic pieces could be expected to withstand the ordinary loads encountered in engineering service without any accumulative ill effects due to repeated stressing. The fracture of these test bars also showed that they tended to act almost as a single unit with no tendency of the hard surface material to spall. Perhaps the most surprising result of all these tests, is the high strength of the bond between Cobalt Chromium Tungsten and a base material. This, of course, is taken for granted in ordinary welding procedure wherein there is considerable penetration of the deposit. In the case of Cobalt Chromium Tungsten deposited with an oxyacetylene torch, however, there is a sharp line of demarcation between the base material and the hard surfacing (see Fig. 14). Both under static and repeated load, and at room temperature and 1000° F., the strength of this junction was superior to both the coating and the base material.

Perhaps the property of greatest direct importance in this material is its hardness at both room and elevated temperatures (see Fig. 13). This property has been investigated on small test specimens which were coated with sufficient Cobalt Chromium Tungsten so that there was no danger of obtaining an erroneous reading due to the relative hardness of the base material. These specimens were tested at room temperature with Brinell, Rockwell and Vickers testing machines and at elevated temperatures by means of a tungsten carbide Brinell ball which was forced into the specimen when both it and the ball were at elevated temperature. Variations in hardness due to prolonged heating were checked by heating the specimens in a separate furnace and transferring them while still hot to the testing furnace after heating periods of as long as 10,000 hours. Tests of this type show that temperatures as high as 1000° F. have practically no effect on the hardness of this material even over prolonged periods of time.

These tests give the hardness of the weld deposit in terms of Brinell hardness readings. For this material such readings seem to give an erroneous idea of the actual hardness. This is illustrated by comparison of a Brinell hardness test, a Rockwell test and a Vickers hardness test on the same Cobalt Chromium Tungsten specimen. For example, if the Brinell hardness is 410, a Rockwell C reading of 47 might be found which would correspond by ordinary conversion to approximately 461 Brinell and a Vickers hardness reading with a diamond indentor and a 30 kilogram load of 550 Vickers Brinell hardness. This indicates there is a variation in hardness number with the size of the impression or the magnitude of the load. The readings can be checked by using varying loads on the Vickers testing machine. The lightest load gives the highest actual hardness number. This might seem to indicate that the deposit varies in hardness through its depth, but any of the usual tests for work hardening, or variation in hardness below the surface, fail to reveal such relationship. If these figures are to be explained at all, apparently it must be in terms of the manner in which the material yields under the indentor. From the practical standpoint, however, the interesting fact is that mere Brinell hardness cannot be trusted as a criterion for comparing a Cobalt Chromium Tungsten deposit to the hardness of other materials. This is confirmed to a certain extent in the machining of such deposits. Cobalt Chromium

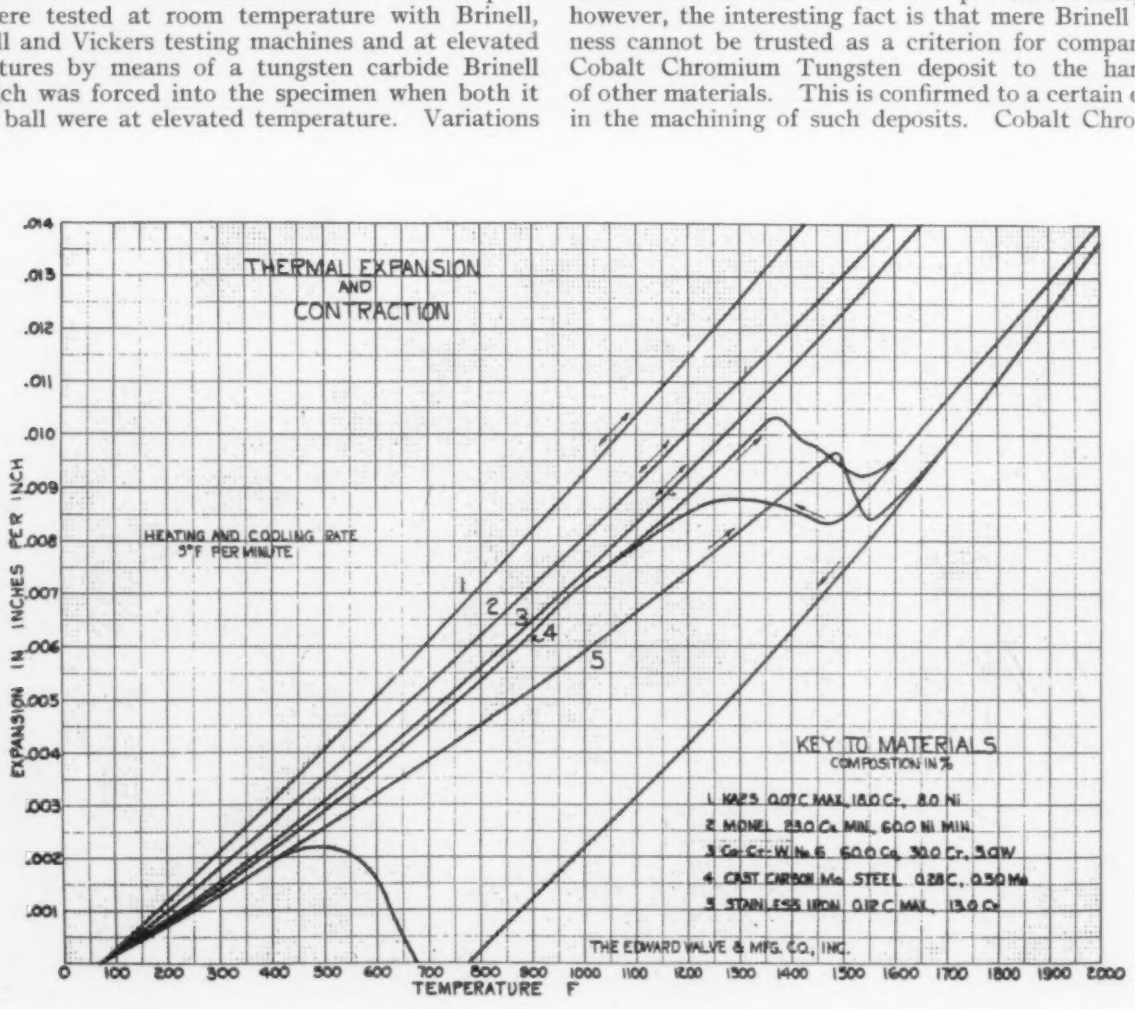

Fig. 15—Thermal Expansion Characteristics of Some Valve Alloys

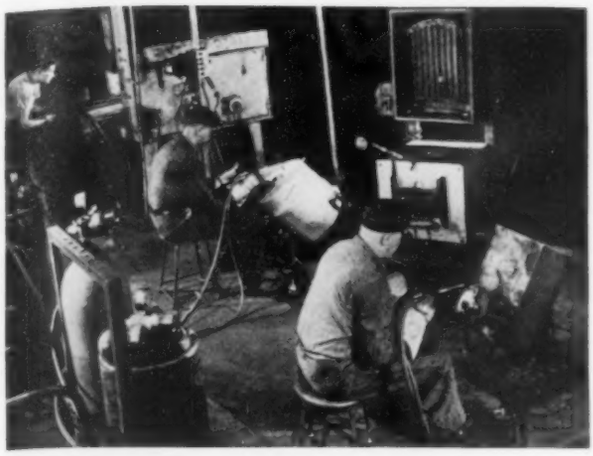

Fig. 16—Preheating Furnaces and Revolving Fixtures for Hard Surfacing Valve Seats and Disks

Tungsten with a Brinell hardness of 410 is more difficult to machine than a stainless steel of similar Brinell hardness.

The question of the effect of the thickness of the deposit on hardness in actually a rather simple one. For ordinary hardness tests, the deposit must be thick enough that the indentor does not deform the base metal underneath. This, of course, is true in the hardness measurement of any material. However, with a well deposited oxyacetylene layer, the actual hardness is quite uniform throughout the deposit. By means of a very small indentor the hardness has been checked throughout a cross section. Until the readings approach the base metal so that the indentor actually breaks through the bond and projects into the base metal, the readings are quite constant. In deposits that have been made electrically there is considerably more alloying between deposit and base metal, hence the hardness may vary.

As has been implied, Cobalt Chromium Tungsten deposited by means of the oxyacetylene torch forms a sharply defined bond between itself and the base material. When properly deposited there is little alloying between the two metals. If the material is improperly deposited and a large part of the base material is melted, considerable alloying may take place but still there will be a sharp line of demarcation between the unaffected base metal and the diluted hard surfacing alloy. Such is also the case if it is deposited electrically. Certain specifications have required that Cobalt Chromium Tungsten facing be applied in several individual layers, one upon the other. Such a procedure might be desirable for electric deposition of this alloy, but it might merely serve to cover up a poor job of oxyacetylene deposition. It has several factors in its disfavor. Three separate layers mean a very thick deposit, which may be inadvisable, inasmuch as it is not a recommended structural material because it exhibits low elongation and reduction of area. Multiple deposits are illustrated in Fig. 14. A single, well deposited oxyacetylene layer of Cobalt Chromium Tungsten seems to represent good hard surfacing procedure.

This résumé of the properties of a Cobalt Chromium Tungsten alloy shows that when it is applied to steel with an oxyacetylene torch, the composite material has practically all the strength of an integral piece of steel except when the loads are high enough to approach the breaking point. Under such an extreme load the alloy tends to break abruptly rather than in the ductile fashion commonly encountered in steels.

The chief problem found in the application of hard surfacing materials is directly associated with low ductility and certain anomalies in the thermal expansion characteristics (see Fig. 15) of most steels used as base materials. Cobalt Chromium Tungsten deposits contract quite uniformly when cooling from very high temperatures, but most steels go through a period in which they actually expand upon cooling rather than contract. Metallurgically, this action takes place within the steel's

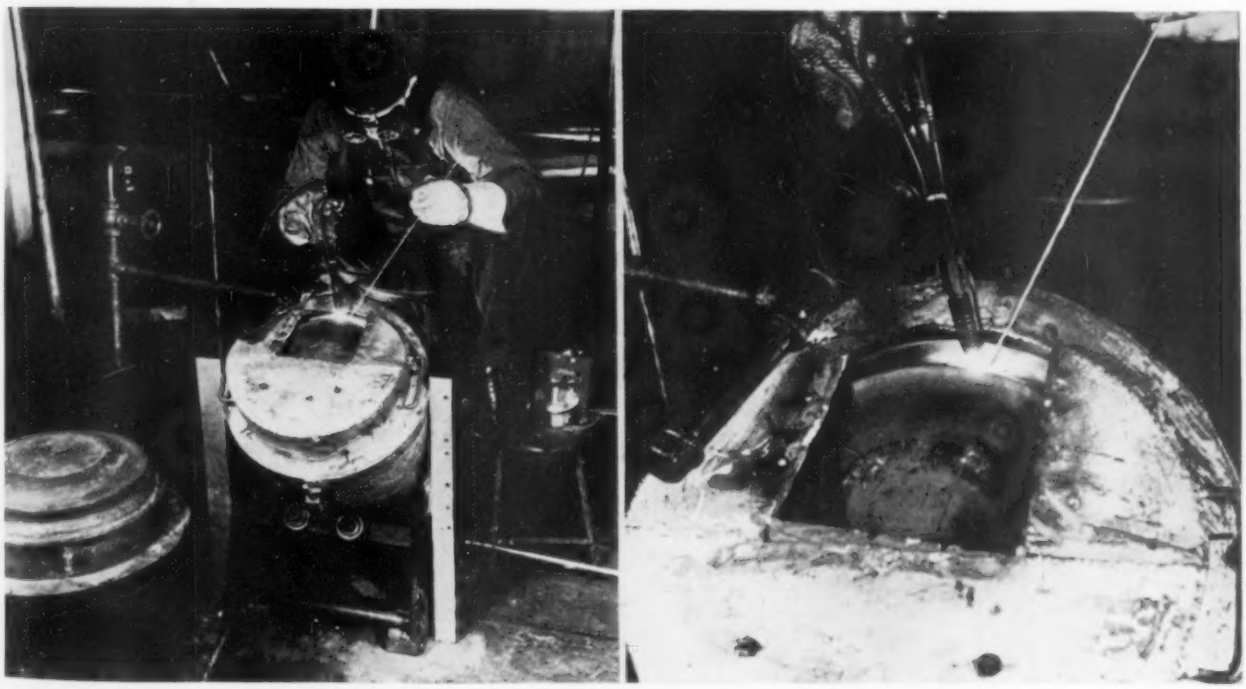

Fig. 17 (Left)—12-Inch Globe Valve Disks Being Hard Surfaced in Motor Operated, Gas Heated, Revolving Fixture. (Right) Close-Up Showing Water Jacketed Welding Torch. Disks Are Kept at 1200° F. During Welding

critical range or critical temperature and accompanies the change in crystal form of the iron. The temperature at which the reversal starts on cooling is the Ar_3 point and the temperature at which it ends the Ar_1 point. This means that when molten Cobalt Chromium Tungsten is deposited on such a base material and the two are subsequently allowed to cool, there will actually be a period in which the base metal is expanding and the deposited alloy is contracting. Such opposite tendencies set up high stresses, and if the size and shape of the piece is such that the stresses are concentrated in the deposited layer, it may very well crack rather than yield.

It is true that there are some steels, notably austenitic, which do not go through this critical expansion range upon heating and cooling, but the commoner grades of these steels have considerably different thermal curves than that of Cobalt Chromium Tungsten. Consequently instead of building a large stress at one particular temperature, the stresses tend to accumulate gradually while cooling until they reach fairly high values at room temperature. Steel which has a different coefficient of expansion than the hard surfacing alloy used in the range from room temperature up to the maximum operating temperature will be subject to renewed stresses during each heating and cooling cycle. Such stresses, in certain valve designs, may be of sufficient magnitude to exceed the fatigue limit of either the deposit or the base material.

Carbon and low-alloy steels all go through this critical range, which may be troublesome during application of Cobalt Chromium Tungsten. Once the process of application has been completed, the coefficients of expansion of the base steels are quite similar to those of the weld deposit. Furthermore, few operating conditions carry the material to temperatures sufficiently high to re-enter the critical range so that the problem is largely confined to the first application. These facts make carbon and low-alloy steels reasonably good base materials for the deposition of Cobalt Chromium Tungsten but still they must be handled rather carefully. The Ar_1 and Ar_3 points are not only a function of the chemical analysis of the steel but also of the cooling rate. In a given steel, slow cooling tends to make grain transformation take place at high temperatures, whereas rapid cooling may depress the transformation temperatures to such low values as 300° F. Obviously if this expansion can be made to occur at temperatures as high as 1300 or 1400° F., where the Cobalt Chromium Tungsten is not quite so hard as it is at room temperature and the steels themselves are relatively plastic, the stresses will be less violent than at lower temperatures where both components are more rigid.

Higher alloy, pearlitic, air hardening steels in general go through a greater amount of expansion in the critical range than the low carbon, lower alloy steels, and the expansion while cooling tends to occur at lower temperatures. This not only makes them troublesome when hard surfacing materials are being applied, but in general their coefficients of expansion in the normal operating range of temperature are lower than that of Cobalt Chromium Tungsten and consequently stresses are repeated with each heating and cooling cycle.

With this background of explanation, the steps necessary in order to obtain a sound deposit regardless of the shape of the piece, are fairly obvious. A base material with suitable expansion characteristics is selected. It is preheated to a temperature slightly below the critical range so that it will not cool rapidly immediately after each drop of Cobalt Chromium Tungsten is deposited. The piece is held at this preheat temperature throughout the application of the deposit, after which it is slowly cooled. When this procedure is carefully followed, the hazard of cracking is reduced regardless of the shape of the piece. This is emphasized because certain shapes do not create high stresses in the hard surfacing deposit regardless of the expansion or contraction of the base material. In such fortunate circumstances, elaborate precautions are less important.

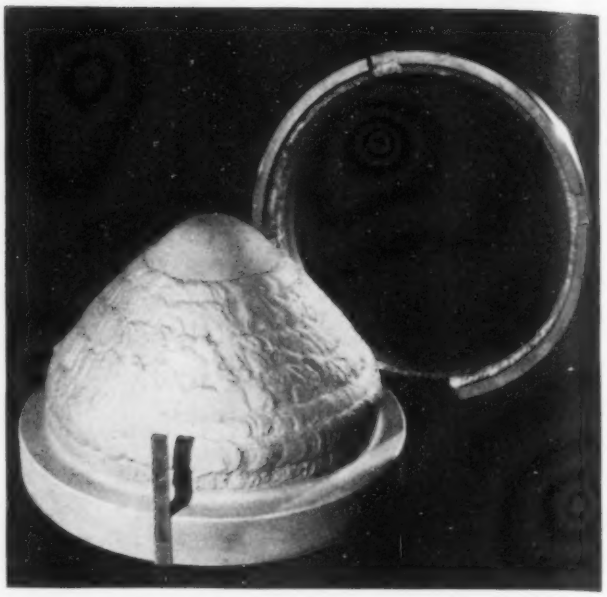

Fig. 18—16-Inch Parabolic Flow Control Disk and Seat for Steam Service. Over 20 Lb. of Hard Surfacing Material for Both Parts Which Are Later Machined to Smooth Finish

The proper selection of base material solves many of the problems that may arise in the hard surfacing of valve parts.

CONCLUSION

Judicious use of welding is employed in the manufacture of high pressure-high temperature designs by practically all steel valve builders. This is pertinent, as power, petroleum and technological processes impose as severe a service on steel valves as can probably be found for any industrial product. Competent valve manufacturers, whose products operate effectively not only at high pressures, but at temperatures varying from minus 100° F. to 1300° F., must constantly engage in comprehensive design and metallurgical research. That welding is so widely used in the valve industry is striking proof of its soundness as a modern manufacturing process.

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WELDING AND CUTTING OF Stainless Clad Steel*

By W. B. KEELOR†

IN THE early part of 1932, the principal metal trade papers announced the development of a process for applying a thin layer of corrosion-resistant chromium nickel stainless steel to a mild steel base. The inventor of the process claimed that it had been proved practical to manufacture stainless clad steel and that a full and complete weld between the plys was produced by a special and unique process. It was also claimed that the thickness of the stainless steel layer could be maintained over the entire area of the sheet or plate. It is indeed gratifying to know that these claims have been substantiated and to see this composite metal take its place among the reliable corrosion-resistant metals available to the present-day designer. Experience has taught the manufacturers of this metal that an alloy layer of twenty per cent of the combined thickness is sufficient to answer the requirements of most applications and allows sheets and plates to be sold at a price far below that of the same analysis in solid stainless steel.

Today, twenty per cent stainless clad steel is being used extensively in the chemical, food, process and diversified industries to eliminate the necessity of frequent replacement of equipment due to corrosion and to keep products from becoming discolored or otherwise contaminated during the process of manufacture. It is also used for many decorative applications where the polished finish on the exposed surface displays all advantageous features of solid stainless steel.

It is possible to obtain stainless clad steel with a wide variety of stainless alloy layer analysis, the most popular being the common Type number 304 18–8. Type 347 Columbium bearing and Type 317 Molybdenum bearing are also produced for applications where their individual merits will justify the slight increase in cost. Since these types are most commonly used and twenty per cent represents the standard for cladding thickness, the following paragraphs will be devoted to explanation of welding and cutting procedures based upon this group.

WELDING PROCESS

Electric metallic arc welding has been found to be the most practical welding method for use in connection with stainless clad steel. The principal reason for this choice lies in the fact that the effect of welding temperatures can be minimized, cost held to a minimum and regular standard equipment, available in most shops, is entirely satisfactory. Very sound and dense weld deposits may also be made with the oxyacetylene process, but it is difficult to control temperatures and, therefore, it becomes necessary to use Type 347 Columbium stabilized analysis, otherwise a substantial amount of the corrosion resistance might be lost in the weld area due to carbide precipitation. It has become common knowledge among the fabricators and users of stainless clad steel equipment that corrosion resistance is retained when the electric metallic arc process is used in connection with a proved welding procedure.

JOINT DESIGN

The design of joints for butt welding varies according to the thickness of sheet or plate and the application for which an installation may be intended. For example, the design for butt welds shown in Fig. 1 is most desirable for thicker plates, particularly for pressure vessel work because it provides for maximum physical properties. The plate edges should be planed approximately as shown, the important point being to leave a thickness of steel in the root of the groove, sufficient to prevent the steel root-weld from penetrating into the stainless layer. (If the root steel weld should penetrate the stainless layer, the resulting alloy deposit would not be sufficiently ductile to fulfil the requirements of free-bend and tension tests for code welding.) The steel side is welded first in multiple layers, exercising care to minimize weld area temperatures. Sufficient time should be allowed between beads to allow the previous weld and immediate area to cool. After the steel weld has been completed, the stainless side is chipped out to a depth sufficient to expose good sound base steel weld metal. The stainless weld is then applied in two passes with 25 Chromium–12 Nickel stainless electrode. The first should be cleaned completely with a roughing chisel before the second is applied. The slight dilution of steel in the first stainless weld does not lower the alloy content of the 25–12 deposit to a point where the corrosion resistance is undesirable. Furthermore, the completed weld made by this procedure will have the desirable alloy content and physical properties sufficient to meet the requirements of code welding.

The design for butt welding shown in Fig. 2 has been the most popular for welding sheets thicker than number 10 U. S. S. gage and plates as thick as $^3/_4$ inch due to the economies it offers. Joint edges are prepared as shown. The stainless side is welded first in one pass. The steel weld is then made without chipping out the root of the steel weld groove. Here it is also necessary to apply the steel weld in multiple layers to control weld area temperatures. With this design, one can expect a slight unwelded area between the root of the stainless and steel welds and, for this reason, this design is not recommended for welding pressure vessels to meet code requirements. It is always important, with this design, to line up the plate edges perfectly to eliminate getting a stainless pick-up in the steel weld. Some fabricators might prefer to leave a slight gap between the plate edges to insure maximum penetration from both

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FIG. 1

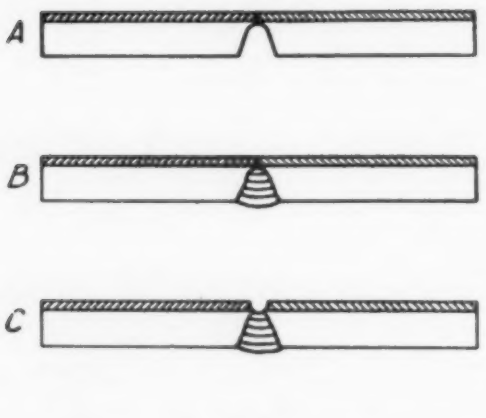


FIG. 2

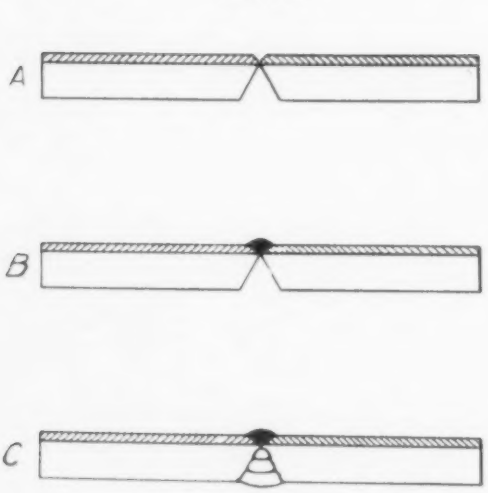
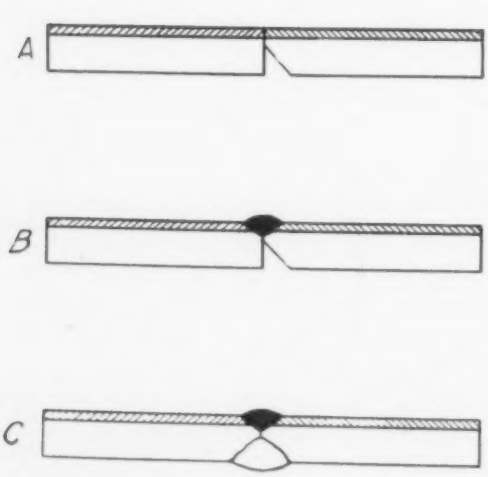


FIG. 3



sides, but it is found that it is difficult to maintain a uniform spacing due to the contraction of the first bead as it is applied. For this reason, it is most practical to butt the edges together and bevel the stainless side as shown to insure sufficient penetration. (One need not fear penetration of the stainless weld into the steel if small electrodes are used.) Three-thirty-second inch diameter for 10 U. S. S. gage to $^{3}/_{16}$ inch plate and $^{1}/_{8}$ inch diameter for $^{3}/_{16}$ inch to $^{3}/_{8}$ inch plate, $^{5}/_{32}$ inch diameter is sufficient for plates $^{1}/_{2}$ inch to 1 inch thick. Tack welds may be made on the steel side with steel electrode or on the stainless side with small diameter stainless electrode. But tacks on the stainless side should be partially ground off before the full weld is applied to guarantee uniform penetration and eliminate slag inclusions.

For butt welding sheets 10 U. S. S. gage and thinner, Fig. 3 represents one design which is used by many. Whether the steel side needs to be beveled will depend upon the sheet thickness. Often, on sheets between 14 and 9 U. S. S. gage, beveling of only one edge is required to guarantee sufficient penetration from the steel side. The stainless side should be welded first with a small diameter 25–12 electrode ($^{3}/_{32}$ inch or $^{5}/_{64}$ inch diameter). The steel side is then welded, exercising care to hold a close arc to avoid overheating. One bead is sufficient. This design demands perfect sheet edge alignment, particularly if the stainless weld is to be polished after welding. Tests should be made on small scrap pieces to prove that the welding amperage and electrode diameter are correct before starting a job. It is difficult on sheets thinner than 10 U. S. S. gage to prevent penetration through the stainless layer and into the steel backing but the added alloy content of the 25–12 electrode is generally sufficient to compensate for the dilution encountered.

Fillet welds should be avoided when possible. Welds made in corners are difficult to clean and grind. Undercutting along the edge of a fillet weld is not at all common but, nevertheless, it is possible and, therefore, flanged and butt-welded joints are preferred to corner welds (see Fig. 5).

When it becomes necessary to weld stainless steel to mild steel (which is common in fabricating stainless clad steel), it is necessary to follow a proved procedure to be certain of sound welds (see Fig. 4). Multiple beads should be applied whenever possible to minimize dilution. High alloy electrodes such as 25 Chromium–12 Nickel or 25 Chromium–20 Nickel are preferred to 18 Chromium–8 Nickel electrodes. Invariably welds are brittle when diluted to a point where the combined alloy content is below 22 per cent. If the higher cost of high alloy electrodes over steel electrodes should be a controlling factor, it is quite necessary to conduct tests to be certain that by running multiple steel beads, dilution could be minimized to a point that the completed weld deposit would have sufficient physical properties to answer the service requirements. Should a diluted weld deposit contain a combined alloy content below 22 per cent, it is possible to experience cracks through the center of the weld as it cools, due to the "Hot Short" characteristic of alloys in this range.

In the preceding paragraphs, no mention has been made toward welding electrodes having Molybdenum or Columbium content plus higher Chromium and Nickel to be used to compensate for dilution. Frankly, the writer is not aware of satisfactory present-day sources for such analysis and doubts whether the need will become acute in the future because the principal uses of Columbium and Molybdenum contained stainless clad steel is in the thicker gages where dilution is no great

problem because the stainless layer is sufficiently thick to prevent melting through.

It is obvious that all conditions or designs for welding stainless clad steel have not been covered in the above comments and it would be well to bear in mind the fact that the manufacturers of this metal maintain service departments and are indeed anxious to assist fabricators and designers with any welding problems that may be encountered.

OXYACETYLENE CUTTING

In addition to the welding procedures heretofore explained, there are other problems which the new fabricator of stainless clad steel might encounter. For example, it might be advisable to cut plates by the oxyacetylene process. Conventional methods for cutting mild steel do not apply. It is necessary to cut from the steel side of the plate. Mechanical cutting machines are necessary because the cut, once started, must continue to its end without interruption. Should the torch be stopped before the cut is completed, it is very difficult to start again due to oxides caused by the heat, which have developed on the stainless portion. To start a cut at the plate edge, it is advisable to apply a small steel weld deposit directly on the plate edge, covering the steel and stainless portions. Start the cut in this weld metal and continue cutting across the plate with the torch inclined about twenty degrees from perpendicular in the direction to which the cut is progressing. Oxygen pressures and speeds should be slightly less than used with similar thickness of mild steel. A slight "drag" in the cut is desirable. The preheat flames should be neutral to slightly carbonizing but in no case oxidizing. A larger preheat flame than normal is preferred.

In order to cut a hole in a stainless clad steel plate as in the case of an opening for a large pipe connection to a tank, it is not practical to do this with a mechanical cutting machine. Therefore, it becomes necessary to cut a groove through the stainless layer, around the outline of the portion of the plate which is to be removed, with a chipping hammer, then the steel can be cut with a manually operated oxyacetylene torch. The cut will have to be cleaned up by grinding but will probably be less expensive than machining.

In closing, I should like to mention that no single fabricator has had or can expect to have the experience in welding, cutting, forming or other operations encountered in the fabrication of stainless clad steel that the mills producing this steel have had in dealing with such problems day by day since this steel has been on the market. They should be consulted for their advice on such problems as "how to form dished and flanged heads for tanks" or regarding sources for preferred welding electrode, etc. New and better methods for welding and cutting of this special metal will at some time in the future be developed and we can expect these manufacturers to be a reliable source for current information.

FIG. 4

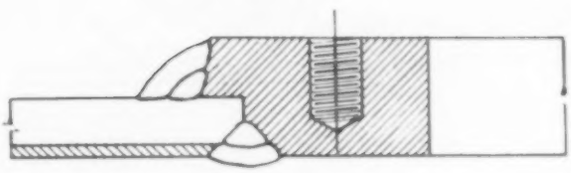
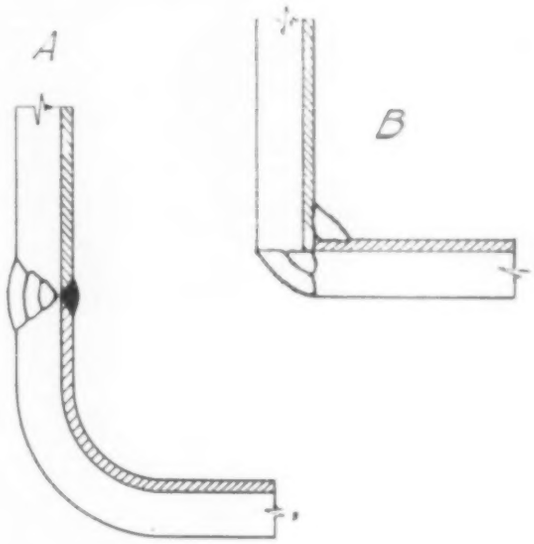


FIG. 5



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(Continued on page 765)

Sections AMERICAN WELDING SOCIETY

CHAIRMEN, SECRETARIES AND REGULAR MEETING DATES

BIRMINGHAM 3rd Fri.
CHAIRMAN—J. W. ADAMS, 209 No. 52nd St., Birmingham, Ala.
SECRETARY-TREAS.—W. L. POOLE, Air Reduction Sales Company, 2825 No 29th Ave., Birmingham, Ala.

BOSTON 3rd Mon.
CHAIRMAN—F. B. MEHAFFEY, Air Reduction Sales Co., 122 Mt. Vernon St., Upham Crs., Dorchester, Mass.
SECRETARY—P. N. RUGG, 16 Fairmount Ave., Wakefield, Mass.

CANTON, OHIO (Akron, Alliance, etc.)
ROBERT M. WALLACE, The Griscom-Russell Company, Massillon, Ohio

CHATTANOOGA, TENN. 1st Wed.
CHAIRMAN—CHESTER RAYMO, Chattanooga Boiler and Tank Company, 1011 East Main Street, Chattanooga
SECRETARY—A. R. MCLAIN, 622 Georgia Avenue, Chattanooga, Tenn.

CHICAGO 3rd Fri.
CHAIRMAN—E. A. BALSLEY, Link-Belt Co.
SECRETARY—M. S. HENDRICKS, Welding Engineer, Room 731, 506 South Wabash Avenue

CINCINNATI, OHIO
CHAIRMAN—JAMES K. ROSS, United Welding Co., Box 247, Cincinnati, Ohio.
SECRETARY—LEWIS B. BLAKENEY, Westinghouse E. & M. Co., 207 N. 3rd St., Cincinnati, Ohio

CLEVELAND 2nd Wed.
CHAIRMAN—F. L. PLUMMER, 2591 Charney Rd.
SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corporation, Cleveland, Ohio

COLORADO 3rd Wed.
CHAIRMAN—J. H. JOHNSON, Johnson Supply Co., Denver, Colo.
SECRETARY-TREAS.—H. W. CREAGER, Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

COLUMBUS, OHIO 2nd Fri.
CHAIRMAN—F. S. CALDWELL, Jeffrey Mfg. Co., Columbus, Ohio
SECRETARY—G. S. HERREN, The Seagrave Corp., Columbus, Ohio

CONNECTICUT 1st. Tues.
CHAIRMAN—JOHN J. VREELAND, Chase Brass & Copper Co., Waterbury, Conn.
SECRETARY—H. A. PENNINGTON, A. B. King & Co., 196 Chapel Street, New Haven, Conn.

DETROIT 1st or 2nd Fri.
CHAIRMAN—H. P. DOUD, General Electric Co., 700 Antoinette, Detroit
SECRETARY—O. L. SMITH, Weldit Acetylene Co. 638 Bagley, Detroit, Mich.

GEORGIA 1st Mon.
CHAIRMAN—D. B. HUNT, 484 Brentwood Dr. N. E., Atlanta, Ga.
SECRETARY—H. J. LEE, P. O. Box 4564, Atlanta, Ga.

HAWAII 4th. Tues.
CHAIRMAN—ROBERT A. PLAUS, W. A. Ramsay, Ltd., Honolulu, T. H.
SECRETARY—ALAN G. SLIPPER, Hawaiian Gas Products Co., P. O. Box 2454, Honolulu, T. H.

INDIANAPOLIS
CHAIRMAN—A. C. RASMUSSEN, Insley Mfg. Corp., Indianapolis, Ind.
SECRETARY—G. HAISLUP, Electric Steel Castings Co., Speedway City, Indianapolis, Ind.

KANSAS CITY, MO. 3rd Mon.
CHAIRMAN—J. L. FIZZELL, National Steel Prods. Co., Kansas City, Mo.
SECRETARY—JAMES P. KIRK, Air Reduction Sales Co., Kansas City, Mo.

LOS ANGELES 3rd Thurs.
CHAIRMAN—C. P. SANDER, Western Pipe & Steel Co., Los Angeles. Calif.
SECRETARY, J. C. GOWING, 644 E. Florence Ave., Los Angeles, Calif.

LOUISIANA 1st Fri.
CHAIRMAN—O. B. MCLAUGHLAN, Freeport Sulphur Co., Port Sulphur La.
SECRETARY—CLYDE PINE, The Isaac Delgado Trade School, New Orleans, La.

MARYLAND 3rd Fri. except April
CHAIRMAN—C. N. HILBINGER, T. A. Canty, Inc., Baltimore, Md.
SECRETARY-TREAS.—R. A. MANSFIELD, Southern Oxygen Co., Baltimore, Md.

MEMPHIS
CHAIRMAN—E. H. GILL, National Butane Gas Co., Memphis, Tenn.

MILWAUKEE 2nd Wed.
CHAIRMAN—R. W. STERNKE, Lakeside Bridge & Steel Co., Milwaukee, Wis.
SECRETARY—GILBERT F. MEYER, Machinery & Welder Corp., Milwaukee, Wis.

MONTANA 1st Wed.
CHAIRMAN—WM. GALLOWAY, 4407-B, Fort Peck, Mont.
SECRETARY—H. S. GRIFFITH, Box 1787, Fort Peck, Mont.

NEW YORK 2nd Tues. except when Joint Meeting is held
CHAIRMAN—CHARLES KANDEL, Craftsweld Equipment Co., Long Island City, N. Y.
SECRETARY—G. V. SLOTTMAN, Air Reduction Sales Co., 60 East 42nd Street, New York, N. Y.

NORTHWEST 3rd Wed.
CHAIRMAN—T. J. WARMINGTON, Wm. Bros. Boiler & Mfg. Co., Minneapolis, Minn.
SECRETARY—ALEXIS CASWELL, Manufacturers Assoc. of Minn., 200 Builders Exchange Bldg., Minneapolis, Minn.

NORTHERN N. Y. Last Thurs.
CHAIRMAN—R. W. CLARK, General Electric Company, Schenectady, N. Y.
SECRETARY—G. A. ROSS, General Electric Co., Schenectady, N. Y.

WESTERN NEW YORK Last Mon.
CHAIRMAN—J. R. DAWSON, Union Carbide and Carbon Res. Labs., Niagara Falls, N. Y.
SECRETARY—C. S. FREEMAN, The Lincoln Electric Company, Buffalo, N. Y.

OKLAHOMA CITY 1st Fri.
CHAIRMAN—K. B. BANKS, P. O. Box 1377, Oklahoma City, Okla.
SECRETARY—C. C. WILLIS, P. O. Box 1498, Oklahoma City, Okla.

OMAHA, NEBRASKA 2nd Thurs.
CHAIRMAN—L. B. THOMAS, Economy Welding Service, 18th & Cuning Sts., Omaha, Nebr.
SECRETARY—G. E. MCGRATH, McGrath Welding Co., 4026 Nicholas, Omaha, Nebr.

PEORIA—CENTRAL ILLINOIS
CHAIRMAN—E. E. ISGREN, R. G. Le Tourneau, Inc., Peoria, Ill.
SECRETARY—W. J. BROOKING, 855 Virginia Ave., Peoria, Ill.

PHILADELPHIA 3rd Mon.
CHAIRMAN—H. R. SALISBURY, Air Reduction Sales Co., Allegheny & 17th Sts., Phila., Pa.
SECRETARY—H. E. HOPKINS, Arcos Corp., 401 N. Broad St. Phila., Pa.

PITTSBURGH Middle Wed.
CHAIRMAN—G. F. WOLFE, Dravo Corp., Engineering Wks Div., Pittsburgh, Pa.
SECRETARY—J. F. MINNOTTE, Minnotte Bros., 1201 House Bldg., Pittsburgh

PUGET SOUND
CHAIRMAN—H. HAYNES, Commercial Boiler Wks., 53 W. Lander St., Seattle Washington
SECRETARY—L. A. BURQUE, Westinghouse Elec. & Mfg. Co., Seattle, Washington

QUAD CITIES
CHAIRMAN—A. R. GUSTAFSON, 840 Third Ave., Moline, Illinois
SECRETARY—J. W. SHUGARS, Lincoln Elec. Co., Moline, Illinois

ROCHESTER, N. Y. 1st Thurs.
CHAIRMAN—EDWIN ALLAN, Allan Iron & Welding Wks., Inc., 133 Murray St.
SECRETARY—PAUL W. JAMES, 17 Lake View Park, Rochester, N. Y.

SAN FRANCISCO Last Fri.
CHAIRMAN—T. R. ROONEY, Western Pipe & Steel Co., San Francisco,, Calif.
SECRETARY—J. G. BOLLINGER, Air Reduction Sales, Park & Halleck Sts., Emeryville, Calif.

SAN JOAQUIN VALLEY
CHAIRMAN—G. D. ATMORE, 401 Santa Barbara St., Santa Paula, Calif.
SECRETARY—A. W. SCHERER, 918 Quincey St., Bakerfield, Calif.

ST. LOUIS 2nd Fri.
CHAIRMAN—N. F. MOSS, 7508 Wayne St. Louis, Mo.
SECRETARY—M. E. MEYERSON, 2317 Chouteau Ave., St. Louis, Mo.

SOUTH TEXAS
CHAIRMAN—L. H. COURTRIGHT, Reed Roller Bit Co., Houston, Texas
SECRETARY—G. V. DYE, G. V. Dye Co., Houston, Texas

TULSA, OKLAHOMA
CHAIRMAN—G. L. WILEY, Box 226, W. Tulsa, Okla.
SECRETARY—O. L. ROGERS, Big Three Welding & Equipment Company, Tulsa, Okla.

YOUNGSTOWN (OHIO) 2nd Mon.
CHAIRMAN—E. W. TROSS, United Eng & Fdy. Co., Youngstown, Ohio
SECRETARY-TREAS.—C. R. RIGGLE, Ohio Edison Co., Youngstown, Ohio

WASHINGTON, D. C. 2nd Tues.
CHAIRMAN—C. A. LOOMIS, Bureau of C. & R. Navy Dept. Washington, D. C.
SECRETARY—G. E. KNOX, Bureau of Yards & Docks, Navy Dept., Washington, D. C.

WICHITA, KANSAS
CHAIRMAN—L. E. KIRK, Vickers Petroleum Co., Wichita, Kansas
SECRETARY-TREAS.—K. O. HOUSER, Kansas Gas & Electric Co., Wichita, Kansas

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Welding Society ACTIVITIES — Related Events

TWENTIETH ANNUAL MEETING

The AMERICAN WELDING SOCIETY celebrated its 20th Annual Meeting in Chicago during the week of October 22nd. It was a record-breaking event in every respect. There was a registered attendance of 1473 members and their guests—an all-time high. Over 29,000 people saw the Metal Exposition and the welding exhibits. 60 technical papers were presented at 15 sessions. These papers covered practically every phase of welding, cutting and allied processes. The large majority of the papers were available in advance through publication in the October Journal or in Preprint form.

The meeting started off according to schedule with a President's Reception on Sunday afternoon. About 350 members participated in this reunion. From the very outset it became apparent that the numerous committees of the Chicago Section in cooperation with the national committees had worked hard and diligently to provide a smooth-running organization to handle all details and emergencies. Throughout the entire week the Chicago members were on the job, leaving their own work, to handle the entertainment, registration, details of meeting rooms, authors' breakfasts, the Welding Society booth, inspection trip, the Annual Dinner, publicity, and a host of other things.

Formally, the technical meetings opened Monday morning, October 23rd, with the keynote address by David Levinger, Asst. to the Vice-President and Works Manager, Hawthorne Plant, Western Electric Company. This admirable talk was quickly followed by the presentation of the Samuel Wylie Miller Memorial Medal Award to Mr. C. J. Holslag by Dr. C. A. Adams, and the Lincoln Gold Medal Award for the best paper of the year to Messrs. G. O. Hoglund and G. S. Bernard and presented by Mr. C. H. Jennings.

Dr. C. A. Adams Presents the Miller Medal to C. J. Holslag

The technical sessions then got under way. All of these sessions were well attended. The discussion was interesting and almost every one present was of the opinion that the attendance at the 20th Annual Meeting was well worth while and profitable in every respect.

The outstanding social event was the 20th Annual Banquet which drew an attendance of nearly 500. The toastmaster Mr. Nathaniel Leverone, President, Automatic Canteen Company of America, added to the enjoyment of the occasion by his humorous introduction of the dignitaries at the speakers' table. He was ably answered on behalf of those present by the President of the Society, Harry C. Boardman, who also humorously reminded the audience that his successor, Mr. George Terry Horton, was also his big boss.

Another social occasions was the Stag Party held on Wednesday evening.

The ladies were provided with a complete program of entertainment, starting with the Reception on Sunday and carrying through Friday. The Ladies Committee was in charge of Mrs. H. C. Boardman, who was ably assisted by 8 other members.

The Welding and Cutting Exhibits and demonstration at the International Amphitheater were one of the high spots in the educational part of the program. 35 companies participated in the welding exhibits.

Other educational items included a round-table discussion on Weldability and a Fundamental Research Conference, both under the auspices of the Welding Research Committee. The three business sessions included a Section Delegate Conference, the Annual Business Meeting and the Board of Directors Meeting.

The Section delegates at their Conference discussed many important items of mutual interest to the Sections of the Society, the districts and the national body. Steps were taken to create the Section Delegates as a permanent advisory committee to the Board of Directors. Special credit is due to Mr. K. L. Hansen, Divisional Vice-President of the Middle Western Division, who presided, and promoted harmony in the solution of some of the most troublesome problems created during the year in the operation of Section activities. The Business Meeting which closed the formal sessions of the Society was a memorial occasion which will probably not be witnessed again for many years to come. The retiring president, Mr. H. C. Boardman, presented his Annual Report, published elsewhere in this Journal, and turned over the duties and honors of the office of the president to his chief, Mr. George Terry Horton, President of the Chicago Bridge and Iron Company, who became his successor. The Directors' Luncheon Meeting followed.

C. H. Jennings Presents the Lincoln Gold Medal to G. O. Hoglund and G. S. Bernard Jr.

On Friday afternoon some 150 members of the AMERICAN WELDING SOCIETY participated in an inspection trip to the plant of the Electro-Motive Corporation. Details of this trip are given elsewhere.

WELDING EXHIBITORS

The welding exhibits in the National Metal Exposition formed one of the chief attractions. A list of the welding exhibitors are as follows;

Air Reduction Sales Co.
American Brass Company
American Steel & Wire Co.
American Welding Society
Arcos Corporation
Automatic Gasflux Co.
Bastian-Blessing Co.
Chase Brass Co.
Dill Mfg. Co.
Federal Machine & Welder Co.
General Electric Co.
Handy & Harman
Harnischfeger Corp.
Haynes Stellite Company
Hobart Bros.
Hollup Corp.
Howell Ind. Truck
Industry & Welding
Krembs & Co.
Lincoln Electric Co.
Linde Air Products Co.
McKay Co.

Machinery & Welder Corp.
Magnaflux Corp.
P. R. Mallory Co.
Maurath, Inc.
Metal & Thermit Corp.
National Cylinder Gas Co.
Page Steel & Wire Co.
Resistance Welders Assn.
Taylor-Winfield Corp.
Una Welding, Inc.
Union Carbide Co.
Wall Calmonoy Corp.
Welding Engineer
Westinghouse Electric & Mfg. Co.
Wilson Welder & Metals Co.

AWARD OF THE LINCOLN AND MILLER MEDALS

Chicago, Illinois, October 23rd—Presentation of the Lincoln Gold Medal for 1938–39 and the 1938 Miller Memorial Medal featured the opening session of the AMERICAN WELDING SOCIETY'S annual meeting this morning at Hotel Stevens.

The Miller Medal, donated by the AMERICAN WELDING SOCIETY to commemorate the contributions of Samuel Wylie Miller to the science and art of welding, was presented to C. J. Holslag, president, general manager and chief engineer of the Electric Arc Cutting and Welding Company, Newark, New Jersey, for his contributions in the development of alternating current arc welding and covered electrodes. Mr. Holslag is a graduate of Columbia University, class of 1908, and is the author of many literary works on various phases of welding. The Miller Medal was presented to Mr. Holslag together with a certificate.

Award of the Lincoln Gold Medal, donated to the AMERICAN WELDING SOCIETY yearly by Mr. James F. Lincoln, Cleveland, Ohio, was made to Messrs. G. O. Hoglund of the Aluminum Company of America, New Kensington, Pa., and G. S. Bernard, Jr., of the Aluminum Cooking Utensil Company, also of New Kensington.

Winner of Miller Memorial Award
C. J. Holslag

Winner of Lincoln Gold Medal
G. O. Hoglund

Winner of Lincoln Gold Medal
G. S. Bernard, Jr.

The award, which is presented each year for the paper judged the greatest original contribution to the advancement and use of welding, was made for "The Effect of Current, Pressure and Time on the Shear Strength and Structure of Spot Welds in the Aluminum Alloys." A requirement for the award is that the paper shall be published in the Journal of the AMERICAN WELDING SOCIETY or presented before one of its meetings. This year's award paper was published in the November 1938 issue of the Society's Journal. A medal, suitably engraved with the author's full name and the year of the award, together with a certificate, was presented to each man. The medals and certificates were duplicates.

Mr. Hoglund has been engaged for 10 years with the Aluminum Company of America developing welding processes applied to the aluminum alloys. Prior to that time he was assistant professor of aeronautical engineering at the University of Minnesota, and for several years with the Bureau of Aeronautics, Navy Department, where he specialized on airplane propeller design. He is a graduate of the University of Michigan, class of 1925, a Bachelor of Science degree in Aeronautical Engineering.

Mr. Bernard has been employed for $3^1/_2$ years by the Aluminum Cooking Utensil Company as an electrical engineer in the Welding Development Division. He is a graduate of Virginia Military Institute, holding a Bachelor of Science degree in Electrical Engineering.

PLANT INSPECTION TRIP

As the final activity of the Society's Twentieth Annual Meeting, a tour of inspection of the Electro-Motive Corporation Plant at La Grange, Ill., was arranged. A group of approximately 175 members and guests left the Stevens Hotel by bus shortly after one o'clock on Friday, October 27th, and spent the rest of the afternoon at the plant, viewing the various operations being carried out in the construction of Diesel-electric switch-engines and streamlined locomotives. An opportunity was provided for watching a number of welding and flame cutting operations in actual progress, and also for inspecting numerous welded structures in all stages of production.

The group showed particular interest in some of the larger all-welded frame structures, such as sides, roofs, underframes, etc., and in the jigs and positioning equipment used in their construction. The welding operation which aroused the greatest interest was the welding of a switch-engine underframe by the Unionmelt process.

The National Program Committee wishes to extend special thanks to Mr. E. Kuehn, Works Manager of the Electro-Motive Corporation Plant, through whose cooperation the inspection trip was made possible.

ANNUAL MEETING COMMITTEES

The success of the Annual Meeting is in a large measure due to the very able committees which handled the innumerable details. As a matter of record, some of these committees are reproduced below.

Registration Committee: A. M. Candy, Chairman; Walter Ahlstrom, R. B. Bradley, Irving Carlson, F. H. Carpenter, C. J. Daniels, C. H. Daugherty, I. J. Eales, I. D. Hayden, R. L. Kohlbry, G. T. Mann, W. C. Pearson, C. L. Pfeiffer, E. R. Seabloom, L. Sebo, A. M. Unger, R. H. Wang, C. D. Young.

Convention Committee: C. A. McCune, General Chairman; M. M. Kelly, Secretary; J. B. Tinnon, Chairman, Manufacturers' Committee; E. V. David, Chairman, Technical Program Committee; R. E. McFarland, Chairman in charge of Local Arrangements; E. A. Balsley, Chairman, Chicago Section; M. S. Hendricks, Secretary, Chicago Section.

Exhibit Committee: J. B. Tinnon, Chairman, Manufacturers' Committee;

(*Continued on page 763*)

ANNUAL REPORT—ACTIVITIES OF THE AMERICAN WELDING SOCIETY

Year Ended September 30, 1939

By H. C. Boardman, President

During the past year the American Welding Society has functioned in a creditable but unpretentious manner, consolidating and building on the extraordinary gains of Mr. Gibson's and Mr. Lang's administrations, keeping in mind its destiny as a technical organization, and laying extensive plans for healthy future growth. There follow detailed reports of its membership, finances, and many and varied activities.

Foresighted and wholehearted support by individual members, sections, committee chairmen, headquarters' staff and industry generally, have enabled the Society to effectively carry on and expand the work of its technical and research committees.

It may confidently be expected that my illustrious successor, Mr. George Terry Horton, will receive the same loyal, generous and efficient help, and guide the Society to higher levels of accomplishment.

Meetings—Board of Directors

During the year the Board of Directors held two meetings, one in Detroit last October and the other in New York in May. In addition the Executive Committee held six meetings in New York. Considerable time has been devoted to plans for expanding the technical activities of the Society, and ways and means of financing these increased activities. After assurance that sufficient funds were at hand for carrying on this enlarged program for the balance of the fiscal year, the employment of an Assistant Technical Secretary was authorized and a committee appointed to select a candidate. This committee rendered its report to the Directors in May and on June 1st the Assistant Technical Secretary, Mr. Leslie M. Dalcher, was added to the staff. In order to secure support for the Society activities on a continual basis, a Ways and Means Committee was appointed, the functions of which include an analysis of the Society's present income from its three major sources (membership dues, Journal advertising and research contributions), and the formulation and carrying out of plans for securing additional revenue from these sources.

During the year, on recommendation of the Sections, committees were also appointed by the Board of Directors to study the following matters:

Section Returns on membership dues.

Consolidation of membership and elimination of inactive Sections.

Establishment of a single expiration date of membership dues.

Regulations Adopted

To improve the Society's methods of operation, the following regulations for the guidance of committees and governing publication of Codes have been adopted by the Board of Directors:

Rules governing organization, functions and operations of the technical committees.

Rules of Procedure for meetings of Board of Directors and Executive Committee.

Rules governing functions and responsibilities of the Publicity Committee.

Rules governing publication of A. W. S codes, specifications and standards.

Permanent Fund Account Established

On recommendation of the Welding Handbook Editorial Committee and by authority of the Board of Directors, funds in the Welding Handbook account in excess of $1000 have been placed in a savings bank to be administered by a Permanent Funds Committee. The Committee on By-Laws has been requested to prepare a Section of the By-Laws providing for the appointment of this committee. A report of the By-Laws Committee has been rendered and will be acted on at the next Executive Committee meeting.

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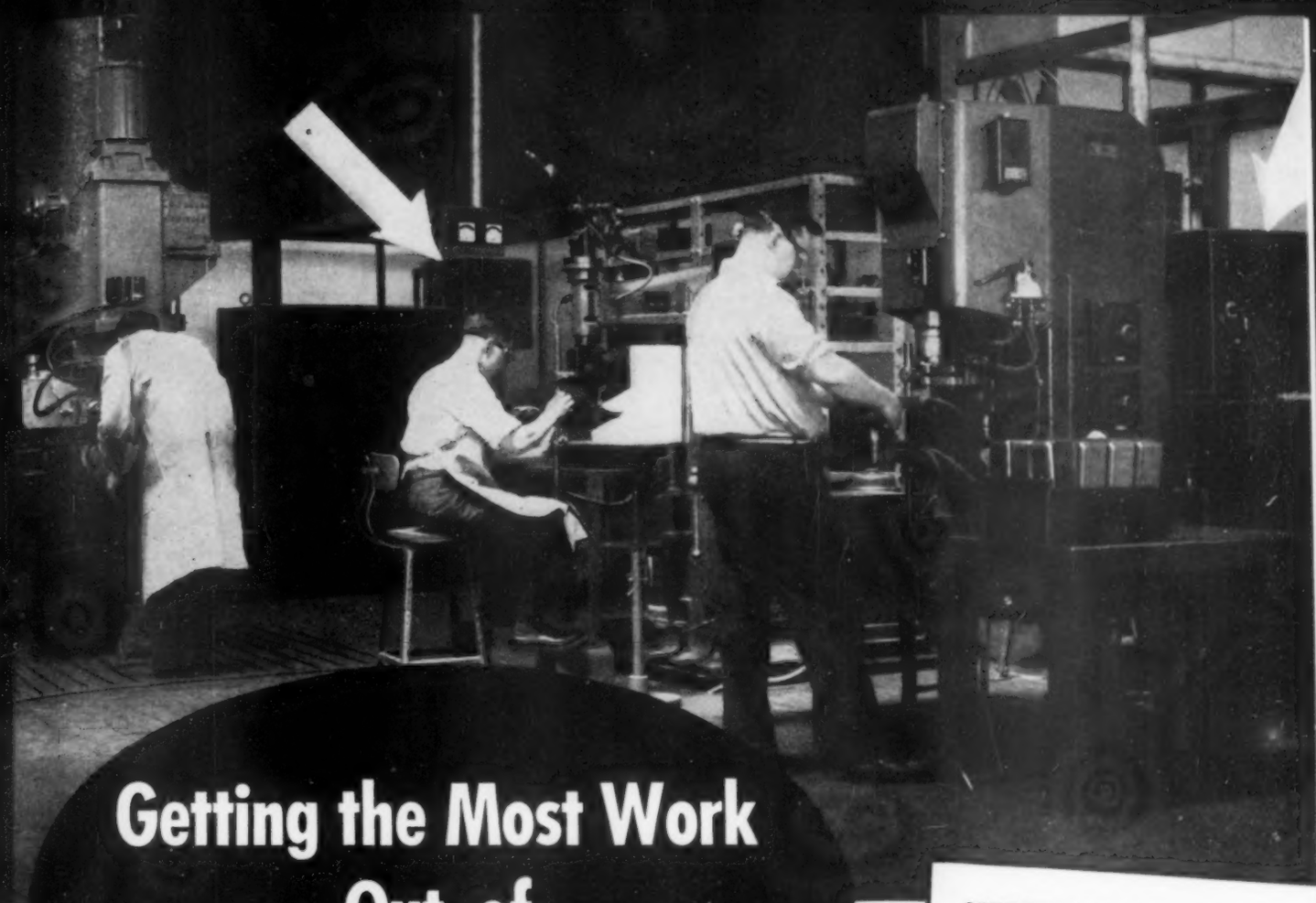


Getting the Most Work Out of Welding Machines

MAXIMUM AVAILABILITY IS ASSURED BY BREAKERS

Put G-E air circuit breakers on guard to protect the electric circuits supplying your welding machines—to interrupt damaging short circuits instantly and safely—to restore service immediately with no time out for fuse replacement—and thus to increase machine availability.

G-E air circuit breakers, when controlled by the automatic action of other devices, can also provide protection against undesirable operating conditions, such as low voltage, faulty timing, and no water flow in transformers.

One of the big features of G-E air circuit breakers: their adjustable overcurrent trip can be set to open the breaker just above the during-welding current value, and below the safe limit for the welding equipment.

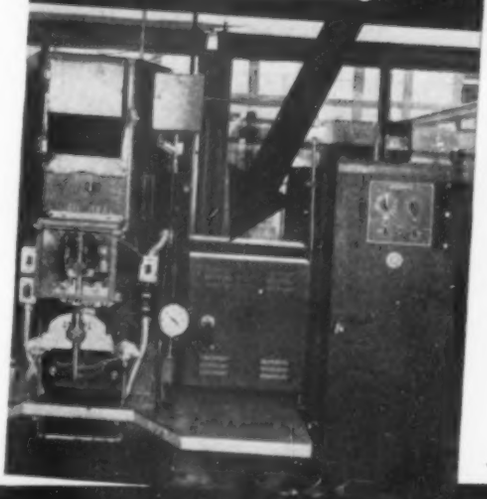
Learn More about Them

—about the arc quencher, which makes possible the interruption of dangerous short circuits before a watch ticks twice—and other notable features described in Leaflet GEA-2997. Ask for a copy. General Electric, Schenectady, N. Y.

HERE'S WHAT A WELDING ENGINEER SAYS:

"These G-E air circuit breakers certainly have protected the welding equipment against damaging overcurrents. On more than one occasion while welding aluminum, the breaker opened so fast that only 1/4 of full-depth indentation was made on the aluminum when the current exceeded the trip setting of the breaker."

HERE'S ONE OF HIS G-E BREAKERS



GENERAL ELECTRIC

890-73

On recommendation of the Welding Handbook Editorial Committee, the Board directed that the $1000 in the Handbook account remain intact for use in the preparation of the second edition of the Welding Handbook.

Fiscal Year Set

By direction of the governing Board, the fiscal year of the Society has been established as commencing October 1st and terminating on September 30th.

F. T. Llewellyn Receives A. W. S. Honor

By unanimous vote of the Board of Directors at its meeting on May 25, 1939, Mr. F. T. Llewellyn was made an Honorary Member of the Society. This honor was conferred because of Mr. Llewellyn's eminent services to welding engineering and his wise counsel in the sound development of the AMERICAN WELDING SOCIETY.

H. M. Priest Replaces F. T. Llewellyn on Board of Directors

On recommendation of the Executive Committee, the Board of Directors elected H. M. Priest, Engineer, Railroad Research Bureau, U. S. Steel Corporation Subsidiaries, Pittsburgh, as a member of the Board to replace F. T. Llewellyn, resigned. Mr. Priest's term of office commenced on June 1, 1939, and he will continue to serve until October 1941.

President's Visits

During the past year, your President visited many of the organized Sections and the preliminary organization meetings of others in process of formation. In some cases these were return visits. Several of the Sections took advantage of his visit to honor him by holding a President's Night. He represented the Society at the Annual Meeting of the International Acetylene Association at Houston, and the American Petroleum Institute in New Orleans, and visited the following places:
Peoria, Illinois, Sept. 7, 1938
Philadelphia, Pennsylvania, Sept. 19, 1938
Cincinnati, Ohio, Nov. 9, 1938
Detroit, Michigan, Nov. 10, 1938
Columbus, Ohio, Nov. 11, 1938
Buffalo, New York, Nov. 17, 1938
Chicago, Illinois, Nov. 18, 1938
Oklahoma City, Oklahoma, Dec. 6, 1938
Tulsa, Oklahoma, Dec. 7, 1938
Minneapolis, Minnesota, Dec. 14, 1938
Birmingham, Alabama, Jan. 18, 1939
Milwaukee, Wisconsin, Jan. 27, 1939
Cleveland, Ohio, Feb. 8, 1939
Houston, Texas, March 10, 1939
Washington, D. C., March 28, 1939
Troy, New York, March 30, 1939
Youngstown, Ohio, April 4, 1939
Memphis, Tennessee, May 1, 1939
Chattanooga, Tennessee, May 2, 1939
Columbus, Ohio, May 11, 1939
New Orleans, Louisiana, May 12, 1939
York, Pennsylvania, Oct. 4, 1939
St. Catherines, Ontario, Can., Oct. 12, 1939

Reports

Outline of Work.—During the year the appointment of the following committees has been authorized by the Board of Directors. In each case appointment has been made upon recommendation of the Committee on Outline of Work. Personnel in some cases has already been approved while in others membership is not yet complete.

New Committees Organized:

- Machinery Code.
- Rules for Field Welding of Storage Tanks.

New Technical Committees Authorized and in Process of Organization:

- Committee to Outline Minimum Requirements of Instructions for Operators in Trade Schools.
- Non-Destructive Tests.
- Code for Welding of High Alloy Steel Engineering Structures.
- Code for Nickel Alloy Structures.
- Grouping of Materials According to Weldability.

Technical Committees Discharged:

- Inspection Methods in Manufacture of U-69 and U-70 Pressure Vessels.
- Oil Storage Tanks.

Technical Committees in Process of Reorganization:

- Filler Metal Specifications Committee—It was proposed that the scope of the Filler Metal Specifications be defined so as to include nonferrous and alloy steels. When report is finished the Committee is to be reorganized and the following Subcommittees appointed:
- Subcommittee on Gas Welding.
- Subcommittee on Copper and Copper Alloys.
- Subcommittee on Aluminum and Aluminum Alloys.
- Subcommittee on High Alloy Steels.
- Subcommittee on Nickel Alloys.
- Standard Qualification Procedure—Scope enlarged to include nonferrous materials.
- Standard Tests for Welds—Scope enlarged to include tolerances for gages for measuring butt and fillet welds.

New Representation on Committees of Other Societies:

- American Standards Association—Standardization Preferred Voltages, 100 Volts and Under; Building Code Requirements for Iron and Steel.
- American Institute of Electrical Engineers—Power Supply for Welding Operations.

Other committees that have been discharged:

- Special Conference Committee with A. W. S. Definitions and Chart Committee and A. S. M. E. Boiler Code Committee on "Non-Pressure vs. Fusion Welding" Terminology.
- Welding Handbook Editorial Committee.
- Special Committee on Preparation of Extended Program of Technical Activities and Budget.
- Special Committee to formulate Rules on Duties, Functions and Responsibilities of the Publicity Committee.
- Special Committee to Select Assistant to the Technical Secretary.
- Structural Steel Committee.

Standards and Codes Presented to the Board of Directors for Approval:

- Standard Methods for Mechanical Testing of Welds.
- Welding Symbols and Instructions for Their Use.

Standards and Codes Presented to the Outline of Work Committee but not yet ready for presentation to the Board of Directors:

- Standard Qualification Procedure.
- Master Chart of Welding Processes and Definitions of Welding Terms.

By authority of the Board of Directors, A. W. S. representatives were appointed by the President on Joint A. P. I.-A. W. S. Committee on Welding of Oil Storage Tanks and on A. W. W. A.-A. W. S. Committee on Welding of Elevated Water Storage Tanks.

By authority of the Board of Directors, the following committees have been renamed:

- Public Relations Committee, formerly known as Legislative Committee.
- Publicity Committee, formerly known as Public Relations Committee.
- Committee on Rules for the Field Welding of Storage Tanks, formerly known as Committee on Welding Standards for Tanks for the Storage of Liquids under Pressure not to exceed 15 lb. per sq. in. plus Hydrostatic Pressure.
- 1939 Ways and Means Committee, formerly known as Committee on Analysis of A. W. S. Income and Formulation of Plans for Securing Additional Revenue.

Finances

The Annual Report of the Finance Committee indicates in the words of our Treasurer "This is the most healthy condition that the Society has experienced in years from a financial standpoint." During the year, the Society received from all sources a sum of $72,276.62 and spent a sum of $68,516.69, leaving a balance for the year's operation of $3759.93. The Treasurer points out that a year ago we had a balance of $1185.19 to take care of liabilities amounting to $3672.37; whereas today we have a cash balance of $4297.02 to take care of liabilities amounting to $1951.61. This condition was accomplished by reason of the following facts:

1. An increase in Journal advertising in the amount of $2800.
2. An increase in Subscriptions and Journal sales in the amount of $3300.
3. An increase in membership dues income, after reduction for refunds to Sections, in amount of $300.

Here's How McKay
CERTIFIES
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McK
STAINLESS
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THE McKAY COMPANY certifies that the electrodes in this package are part of a lot that have been tested within the recommended current and voltage ranges. The resultant Weld Deposit when uncontaminated by parent metal was found to analyze as shown:
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ANALYSIS
Chromium 19.08
Nickel 10.21
Carbon .057
Columbium
Molybdenum
THE McKAY COMPANY - PITTSBURGH, PA.
THIS CERTIFICATE
on every
WATERPROOF PACKAGE
of
McKAY
McK
STAINLESS
ELECTRODES
Certified
Made by the makers of the "researched" line of quality electrodes, and the famous line of McKay Chains.
THE McKAY COMPANY • PITTSBURGH, PA.
Sales Offices: York, Pa.

4. Economies effected at headquarters through the installation of additional office equipment and systemization of methods of office operation.

It is also worthy to note that for the first time the AMERICAN WELDING SOCIETY has certain moneys ear-marked "Permanent Funds" which have been accumulated so far through the efforts of the Handbook Committee. Although this is a modest beginning, it is hoped that one way or another these Permanent Funds will grow and add to the stability of the AMERICAN WELDING SOCIETY.

Membership

Plans for the reorganization and activities of the National Membership Committee as formulated at the Membership Committee Meeting last fall have been carried out and maintained throughout the year, resulting in close and active cooperation between the local and national membership organizations.

While no special drive for membership has been conducted by the National Membership Committee this year, the Committee has concerned itself with furthering and coordinating local interest in building up membership. As an incentive to spur the Sections on to further activities, a cash prize of $50.00 donated by the Chairman of the Membership Committee was offered to the Section showing the highest percentage gain in membership over a three-month period. The close of the contest showed Chattanooga to be winner.

Many of the Sections are now conducting a Member-for-Member drive which will probably produce a healthy increase in membership. It is to be expected that the supplemental efforts of the Ways and Means Committee will also be productive of splendid results.

Gain in membership is given in the Table.

Membership Status as of October 1, 1939

	A	B	C	D	E	F	TOTAL
Total Membership, October 1, 1938	88	987	1586	786	1	90	3538
Increase during year	8	290	347	349	1	28	1023
	96	1277	1933	1135	2	118	4561
Decrease during year	9	131	370	275	.	83	869
Total Membership, October 1, 1939	87	1146	1563	860	2	35	3693
Net change during year	−1	159	−23	74	1	−55	155

Sections.—Most of the Sections of the Society have been unusually active during the past year. Regular monthly meetings have been held, and in addition in a number of cases successful lecture courses have been conducted. With a few exceptions all have completed their programs for the coming season. Attempts have been made to assist the Sections in the Northwest and Southwest in securing notable speakers for their meetings by arranging lecture tours. The plan which is intended to conserve the time and expenses of speakers by having them deliver a talk before three or four Sections on one trip, is working out nicely. The Sections and most of the Publicity Departments of our company members have cooperated wholeheartedly in this movement. The New York, St. Louis, Peoria and Connecticut Sections and the entire Kansas City, Wichita, Oklahoma City, Tulsa, Houston group have been particularly energetic in lining up their programs.

Three new Sections have been organized during the past year:

Puget Sound, with headquarters at Seattle, organized April 17, 1939;

Louisiana, with headquarters at New Orleans, organized May 12, 1939;

Quad-Cities, comprising Davenport, Iowa; Rock Island, Moline and East Moline, Illinois, organized April 12, 1939.

Due to inactivity the Portland Section was disbanded by vote of the Executive Committee at its meeting of September 14th. A number of projected Sections in which definite interest has been manifested during the past year include York, Pennsylvania; Wilmington, Delaware; Grand Rapids, Michigan; Toledo, Ohio; Casper, Wyoming; Louisville, Kentucky. It is certain that the York Section will be organized soon.

Data on the Sections are given below.

Number of Sections—41

Number of Meetings held—185

Publicity.—In its activities the Publicity Committee has been guided by rules and regulations drawn up by a special committee and approved by the Board of Directors.

In the way of general publicity, the Committee has prepared news releases high-lighting the President's report presented at the Annual Meeting; offered suggestions for improvement in the Membership Leaflet before it was reprinted; prepared a series of advertisements for appearance in the Society Journal, *Industry and Welding* and *Welding Engineer*, prepared posters and program circulars for lecture course given by the New York Section. The Committee had no requests from other Sections for assistance in publicizing either their meetings or lecture courses.

The outline of 1939 Annual Meeting Publicity prepared by the Committee closely followed the rules governing this activity. Work was divided among the individual members and each willingly accepted the task assigned to him and is carrying it to completion. Suggestions for additional publicity proposed by the Convention Committee have been carried out.

The Publicity Chairman has cooperated with other committees of the Society. He attended a meeting of the 1939 Ways and Means Committee and made recommendations for publicity in connection with drive for funds that that committee had planned.

He discussed with the Technical Secretary of the A. W. S. several promotional talks and a proposed new pamphlet submitted by Mr. A. F. Davis of the Membership Committee and made several recommendations. Through correspondence with Mr. Davis and with Mr. Hendricks of the *Welding Engineer*, he also cooperated with the Membership Committee in formulating a plan whereby the *Welding Engineer*, instead of discontinuing its donation of advertising space to the Society, would continue to run advertisements for it although on a somewhat diminished schedule.

Admission to Membership.—No meetings of this Committee have been held as it was found feasible to conduct business by correspondence. Cases in doubt as to the applicant's eligibility to the class applied for were referred to the Committee. The Committee rendered its decisions on these cases and the applicants were accordingly informed.

By-Law Revisions.—During the past year the Committee on Revision of By-Laws has been concerned primarily in reviewing the By-Laws of new Sections, and revised editions of others.

It also approved of wording of revision of By-Law (Section VIII, Section 1-*j*) relating to personnel of Committee on Outline of Work. This amended By-Law has been submitted and now stands approved by the members of the Society.

The By-Laws Committee at the request of the Directors has drawn up a Section of the By-Laws to provide for the appointment of a Permanent Funds Committee. Action on this matter will be taken at the next Executive Committee Meeting.

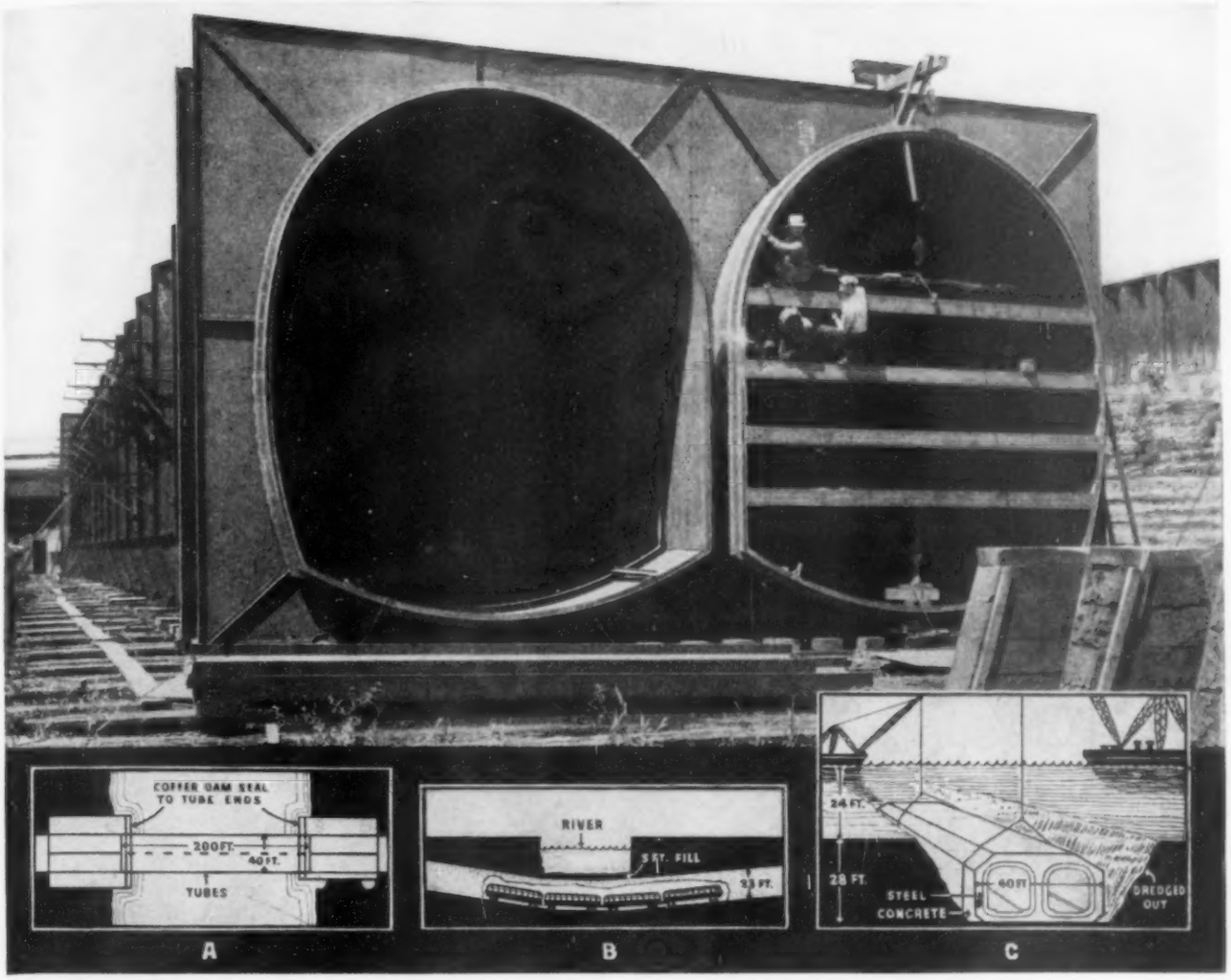
1939 Medal Awards.—The Board of Awards has selected the following Candidates for the 1939 awards:

Samuel Wylie Miller Memorial Medal—Claude J. Holslag.

Lincoln Gold Medals—Gustav O. Hoglund and George S. Bernard, Jr., co-authors of the paper, "The Effect of Current Pressure and Time on the Shear Strength and Structure of Spot Welds in the Aluminum Alloys."

Convention, Manufacturers and Program.—The 1938 Annual Meeting of the AMERICAN WELDING SOCIETY held in Detroit October 16–21 was a great success. There were record-breaking attendances at the technical sessions, social functions and at the Exposition. The number of welding exhibitors (40) exceeded that of other years.

Forty-six papers on subjects giving a cross section of welding developments and research during the previous year were presented at the technical sessions. Simultaneous sessions were held for the first time at the 1938 meeting.



GIANT WELDED TUBE IMPROVES SUBWAY CONSTRUCTION

PROJECT—Twin tube river tunnel in Chicago's new subway system 200 ft. long, 40 ft. wide, 23 ft. high. General Contractors: Merritt-Chapman & Scott. Builders of welded steel tube structure: Graver Tank & Mfg. Co., Inc., E. Chicago, Ind.

CONSTRUCTION—Steel core structure, comprising 5/16-in. plate with T-bar stiffeners, all welded with Lincoln *"Shield-Arc"* Welders and "Fleetweld 5" Electrodes. Steel lined with concrete with inside and outside walls 1 ft.-3 in. to 3 ft. thick. Total weight of tube section 6,500 tons.

INSTALLATION—Tube section sealed at both ends by bulkheads and towed from dry dock 22 miles to Chicago River crossing. To be sunk into dredged channel. See (c). Connected and sealed to cofferdams at sides of river. See (a). Bulkheads then to be cut out.

ADVANTAGES—This method minimizes: (1) depth of tube below river bottom, (2) grade in approaching the tubes and (3) amount of excavation. See (b). Welding assures a strong, rigid structure with savings in weight and construction cost.

For details on other profitable applications of *"Shield-Arc"* Welding, consult the nearest Lincoln office or mail the coupon.

Largest Manufacturers of Arc Welding Equipment in the World

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Send free booklet ☐ "Welding in Construction Work."
☐ "The New *Shield-Arc*."

Name _____ Position _____

Company _____

Address _____

City _____ State _____

The Convention, Manufacturers and Program Committees have spent considerable time and effort on arrangements for the 1939 Annual Meeting and it is expected it will surpass those of all previous years. These three committees have also considered the advisability of holding District Meetings and their recommendations are to be considered at the next Executive Committee meeting.

Meetings and Papers.—The Meetings and Papers Committee has under its general jurisdiction (1) the publication of THE WELDING JOURNAL, and (2) the Technical Program of the Annual Meeting. Quite a number of improvements were made in the Journal during the past year. The news items relating to the welding industry have been materially increased and so positioned in the Journal as to allow every advertisement in the Journal to have some reading matter next to it, thus making every advertisement preferred space. This step has assisted in securing additional advertising. The Journal has received worldwide praise and it is believed that the instructive and interesting articles published make the Journal compare favorably with other technical papers.

The Research Supplement of THE WELDING JOURNAL and the monthly bulletins of the Welding Research Committee continue to be one of the greatest assets to the Journal. This material is a chronicle of the progress of systematic and organized research which is of benefit to the entire industry. The critical digests of literature in the opinion of the experts all over the world, make the Journal a unique source of information which it would be impossible to obtain from any other source. The total number of pages published for the year ending September 1939 was 1316, which is a slight increase over the amount published last year—1290.

The principal activity of the Program Committee consists of arrangements for the Annual Meeting. When called upon it also assists in the preparation of programs for district and sectional meetings. This year some 56 papers will be presented at 15 technical sessions. The program is by far the most outstanding in the history of the AMERICAN WELDING SOCIETY.

Education.—As the duties of this Committee are limited to stimulating and aiding the Sections in the preparation of lecture courses, and none of the Sections has asked for assistance during the past year, the Committee has been inactive.

Public Relations.—The primary function of this Committee is to deal with state and federal legislative matters detrimental to welding which are brought to the attention of the Society. As in the past this Committee has rendered invaluable but unobtrusive service.

Code of Principles of Conduct.—It is pleasing to report that it has been found unnecessary for this Committee to function during the past year.

1939 Ways and Means.—The Committee was appointed on January 12, 1939, for the purpose of analyzing the income of the Society from Membership Dues, Advertising and Contributions to Research Work in order that a more equitable and balanced distribution of income from the various companies affiliated with the Society, might be planned. A second objective was to lay plans for securing this additional income and carrying out these plans. The Committee has held five meetings.

One of the first steps was to compile a list of 185 pages which included the names of companies supporting the Society, the addresses, the present number of members and their classifications, and the income received from Advertising and from Research from each of these companies. Space was provided for filling in amounts of expected additional income from each of these sources. Subcommittees will be appointed in most of the principal sections to assist the 1939 Ways and Means Committee in carrying out its plans. Supplementary literature including a general statement on the work of the Society and the Research Committee was prepared, as was also a statement depicting the importance of welding in key industries. Necessary literature and publicity campaigns are also being planned to make the work most effective.

Returns to Sections on Membership Dues

The Board of Directors, acting upon a petition signed by a number of Section representatives (at its meeting on Oct. 21, 1938), appointed a Committee to make a thorough study of Returns to Sections on membership dues.

HAVE YOU A PRODUCT THAT SHOULD BE DESIGNED FOR WELDING?
Hollup Engineers will help you design or redesign your product for greater strength, less weight and simplicity.
We invite you to submit your welding problems to our design engineers.
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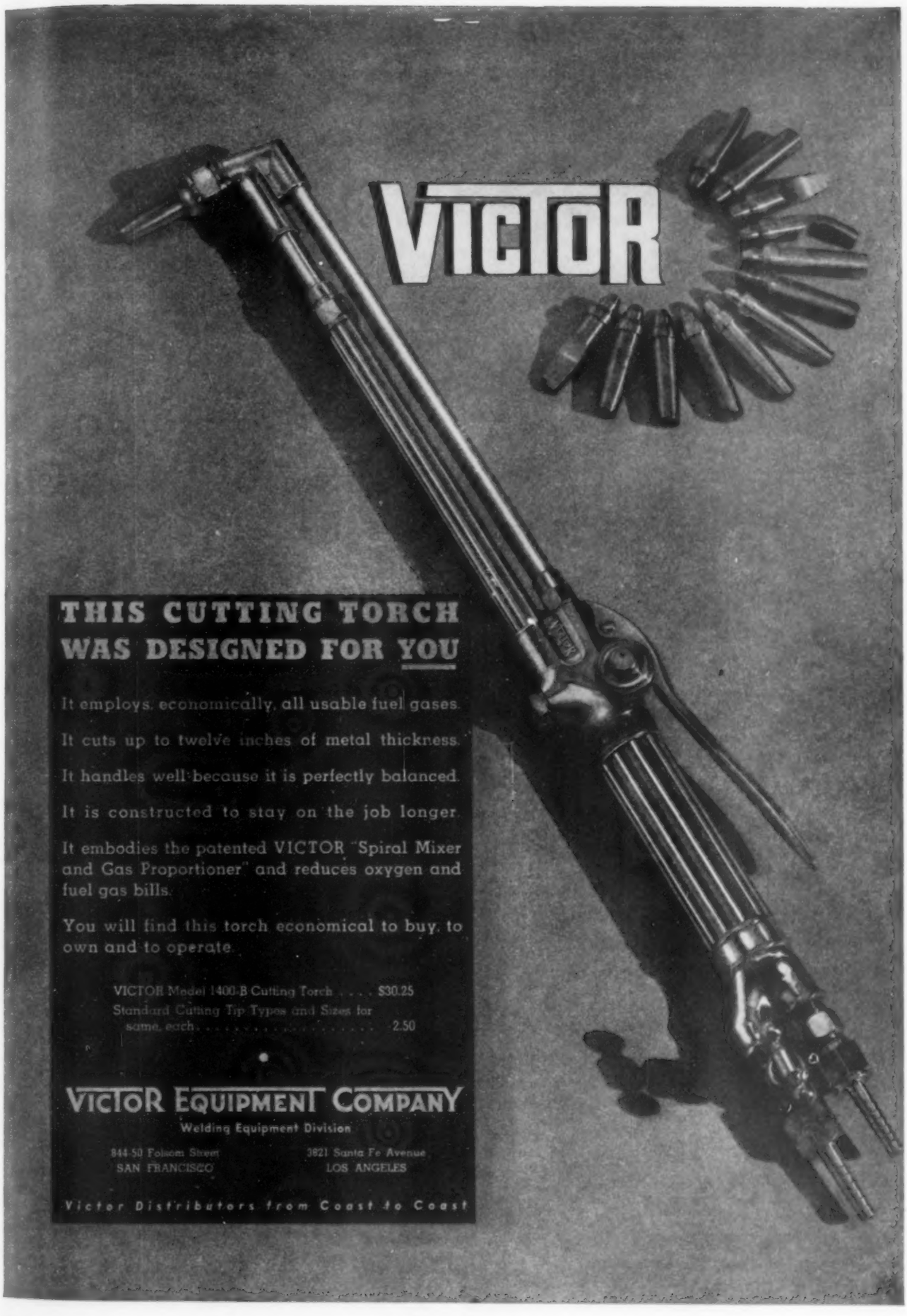
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This Committee, under the Chairmanship of Mr. McFarland, worked diligently over a period of nearly a year to discover some plan which would, in so far as possible, meet the following conflicting conditions:

1. Acceptance by most of the Sections.
2. Distribution of total income of Society in such a way as to provide for varied activities as Section Activities, Journal, Technical Activities, National Meetings, and the like.
3. Distribution of total returns to Sections in such a way as to provide for the needs of the small, medium and large size Sections.
4. Workability from a bookkeeping viewpoint, and source of a minimum of misunderstandings between National and Sections Headquarters.

The difficulty of securing unanimity of opinion is attested by the fact that some seven plans were proposed of varying character.

As a result of their deliberations, the Committee submitted a report which was concurred in by all the members of the Committee except one who submitted a minority report.

The matter was considered by the Executive Committee at its meeting on September 14th. It was the sense of that meeting that the plan proposed would take too much from the National Treasury. Your president was requested to go into this matter further with the Section Officers at their Conference to be held during the Annual Meeting and to propose a plan which would keep the total return to the Sections at about 25% of the total gross dues received from A, B and C members in Sections.

Consolidation of Membership and Elimination of Inactive Sections

The Board of Directors, acting upon a Resolution adopted at the Section Officers' Conference, Oct. 21, 1938, appointed a Committee to make a study of this matter. It is expected that this Committee will render report to the Executive Committee at its next meeting.

Establishment of Single Expiration Date of Membership Dues

This Committee was appointed at the request of Section representatives at their meeting on October 21, 1938. The Committee has given the subject very careful study and will shortly offer definite recommendations.

Technical Activities

This has been a year of very considerable progress in the technical activities of the Society. Two new Codes were approved, two others are practically complete, seven new committees were organized, two were discharged, and the scope of three other committees has been extended. Much credit for this progress belongs to the Committee on Outline of Work, which has held five meetings during the year, and to the individual committees in charge of specific codes and standards.

It is difficult for the outsider to realize the enormous amount of work and the real contributions of time and money represented in these technical activities.

A condensed summary of committee activities follows. There is also included a brief account of the cooperative work of the AMERICAN WELDING SOCIETY with other organizations along technical lines.

Indications are that the coming year will witness still greater progress. In this connection the services of the newly appointed Assistant Technical Secretary will be of material help to the committees.

Summary of Committee Activities

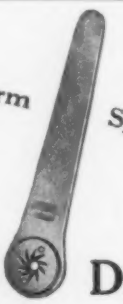
Committee on Building Codes

The provisions of our Building Code have now been adopted by more than two hundred municipalities, including the great metropolitan centers of New York, Chicago, Pittsburgh and Baltimore. This Committee promoted progress in the adoption of the 1937 Building Code by various municipalities.

Conference Committee on Welded Bridges

The Bridge Specifications were revised and published in 1938. They have been approved by the American Railway Engineering Association and American Association of State Highway Officials. Subcommittees on Workmanship and Butt Welds and Welding Technique have been active in preparing further revisions. The Committee has cooperated with Committees on Filler Metal, Qualification Pro-

☆ Better and More Uniform Spot Welds
☆ Less "Down" Time
☆ Lower Dressing Costs
with the New



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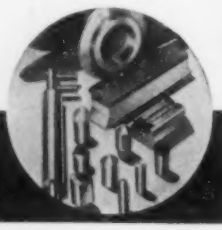

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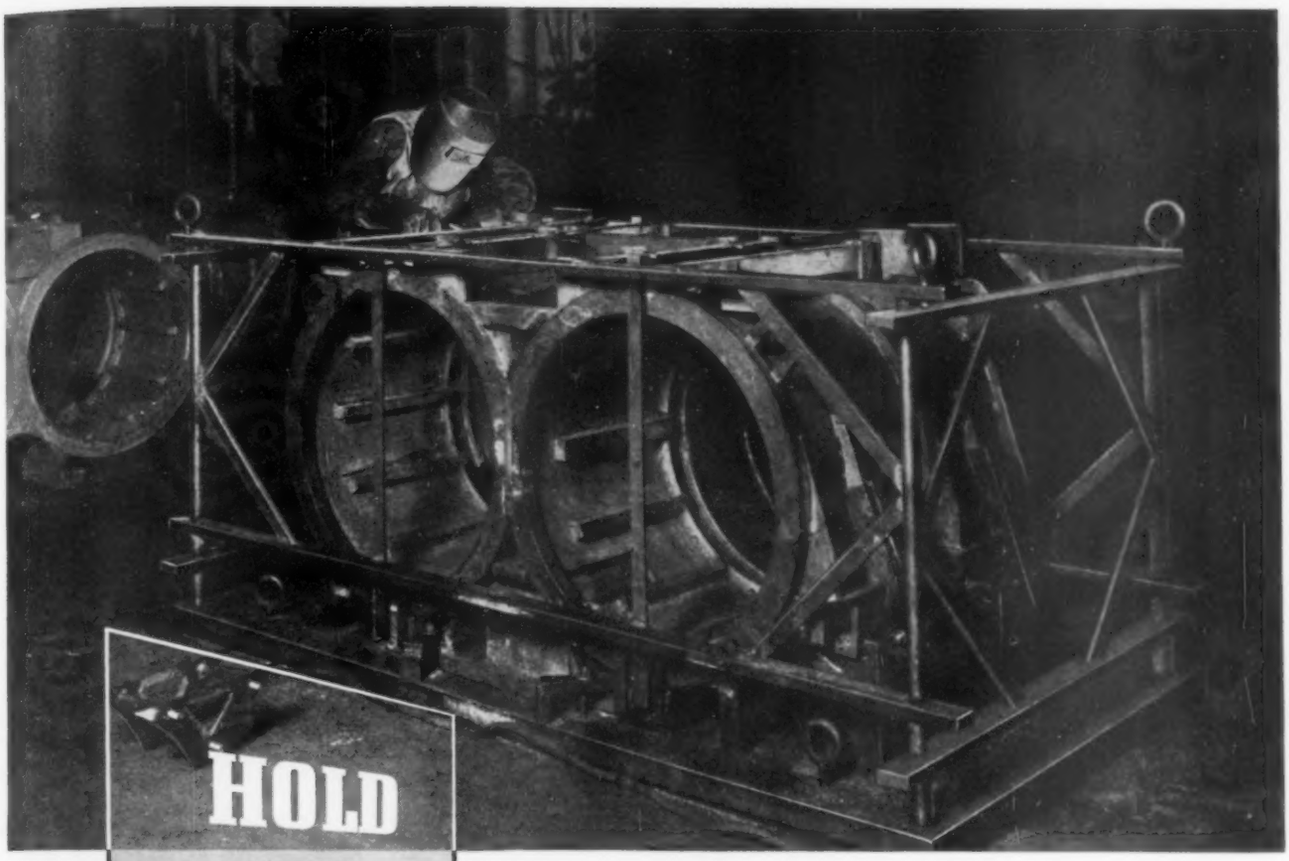

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cedure and Standard Tests for Welds in so far as they relate to the work of the Bridge Committee. The present Specifications will be revised and brought up to date and issued in 1940. It is hoped that the results of research work on Fatigue Strength of Welded Joints will then be available.

Committee on Large Pipe for Hydraulic Purposes

A first draft of the Code was formulated and submitted to members of the Committee and to a few leading manufacturers for discussion and comment. Based on this discussion and comment a second draft has been drawn. Copies have been mimeographed and again distributed to the members of the Committee with a wider distribution among members. Based on the comment and criticism received from this second review it should be possible to draft a definite tentative Code. It is hoped that this objective may be reached during the year.

Committee on Symbols

The AMERICAN WELDING SOCIETY Committee on Symbols is also a Joint Committee of the American Standards Association on the same topic. Some minor changes have been suggested in the AMERICAN WELDING SOCIETY report on this subject, and, if these are adopted by both organizations, these symbols will become the American Standard.

The report has been approved by the Board of Directors of the AMERICAN WELDING SOCIETY and enough copies to meet the needs of industry will be made available by the Society until the A. S. A. can act.

The Symbols Committee is also the Committee on Standardized Welding Specification Reference for Use in the Tails of the Arrows. Some progress has been made in these references.

Committee on Definitions and Chart

During the year the Committee prepared a Master Chart of Welding Processes and a set of Definitions. These were set up in proof form and submitted to a large number of people for comments. These comments have been correlated and it is expected that the Committee will shortly be able to present its final report to the Board of Directors for adoption. Additional work will be needed on new terms and further modification of the main chart.

Committee on Code for Pressure Piping

The Committee on Pressure Piping of the AMERICAN WELDING SOCIETY is identical with the American Standards Association Sectional Committee on Code for Pressure Piping, Subcommittee No. 8, Subgroup No. 4. During the past year the Committee has held several meetings and has about completed its assignment.

Committee on Standard Qualification Procedure

This report has been revised and the first draft was issued in mimeographed form to a number of people for comments. Based on these comments work is now under way on the revision. The principles of the Standard Qualification Procedure as revised, have been adopted by the Boiler Code Committee for revision of Par. P-112 of the Boiler Code. The Standard Qualification Procedure Committee expects to meet shortly and complete the revision. When that has been done the Committee intends to give consideration to the desirability of a Standard Qualification Procedure for automatic processes of welding and also for the welding of brittle materials or those which cannot suitably be tested by the guided bend test as outlined in the present Standard Qualification Procedure.

Conference Committee with A. S. M. E. Boiler Code Committee

During the early days and for a number of years, this Committee was of great help to the Boiler Code Committee and kept the revisions relating to welding in conformity with the ideas of the AMERICAN WELDING SOCIETY. More recently the Committee has not been active. Complete revision of duties, methods of making assignment to the Committee, and personnel is underway.

Committee on Welding of Oil Storage Tanks (Now Joint Committee with A. P. I.)

There has been no active work either in revision or interpretation of the new rules

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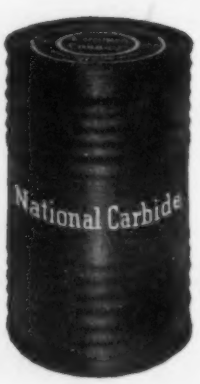

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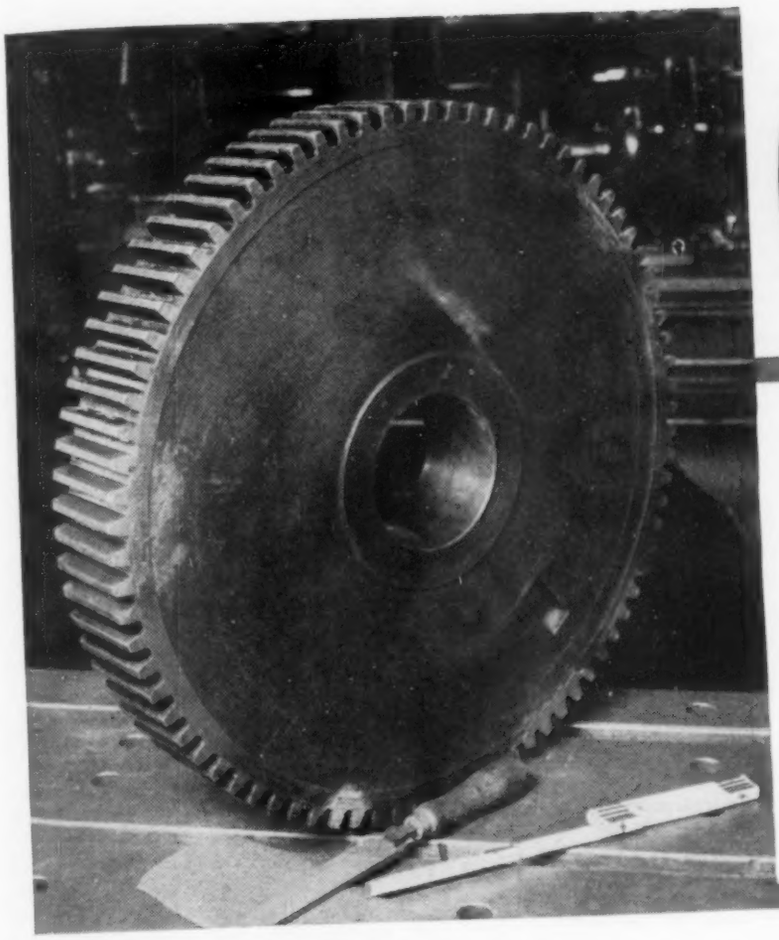

This steel gear broke down six different times over a period of three years. All repair welds were made with Anaconda 997 Low Fuming Rods, and *each succeeding fracture occurred outside of any previously welded area* — interesting evidence of the dependability of welds made with this tough Anaconda Rod.

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reported on last year. In order to eliminate conflict with the Code of the American Petroleum Institute, a joint Committee has been appointed to cover the welding features, the A. W. S. Committee on Welding of Oil Storage Tanks has been discharged, and publication of the A.W.S. rules discontinued.

Committee on Rules for the Welding of Gravity Tanks, Tank Risers and Towers

The second revision of the Code was issued in 1938. There is some question as to the desirability of continuing this Committee in view of existing committees which deal with Codes for Elevated Water Storage Tanks, joint A. P. I.-A. W. S. Code Committee for Oil Storage Tanks and A. W. S. Committee on Rules for the Field Welding of Storage Tanks.

Machinery Code

This Committee was recently appointed but has been extremely active. As a result the Committee has prepared the first draft of the Tentative Code which has been submitted to the members for their approval. Subcommittees have been appointed to cover special portions of the code.

Standard Tests for Welds

This Committee has prepared a report entitled, "Standard Methods for Mechanical Testing of Welds." These standards were set up in proof form and distributed widely for comments. Based on these comments revisions were made and the report submitted to the Board of Directors for approval. There are a few minor items needing adjustment and it is expected that these standards will be issued very shortly.

Committee on Welding in Marine Construction

Subcommittees have been active on Thermal Stresses and on Marine Pressure Piping. Rules on the latter subject have now been issued.

Committee on Filler Metal Specifications

The Committee has undertaken revision of the Filler Metal Specifications issued in 1938 with the idea of their simplification. Separate specifications will be issued for Gas and Arc Welding. The Arc Welding Specification has been prepared in preliminary form and is being submitted to a number of people for comments and criticisms. It is expected that this Specification will be issued as a joint Specification with the A. S. T. M. As soon as issued, corresponding specifications will be undertaken for Gas Welding and for Alloy Steels and Non-Ferrous materials.

Committee on Welding of Elevated Water Storage Tanks

This Committee is cooperating with the American Water Works Association in the preparation of a Code for the Welding of Large Elevated Storage Tanks. It is expected that very shortly the first draft of the Code will be available for comments.

Committee on Code for the Field Welding of Storage Tanks

This Committee was recently appointed but has already prepared the first draft of a Code on this subject. It is now being revised in committee and, it is expected, will be available for general comment sometime during the coming year.

Committee on Minimum Requirements of Instructions for Operators in Trade Schools

Several states have recently passed legislation making it necessary for trade schools to be licensed. The A. W. S. has accordingly been requested to prepare minimum requirements for courses of instructions for trade schools and a Committee has been authorized.

Safety Recommendations

A Medical Advisory Committee of three has been appointed during the year, as has also a Subcommittee on Recommended Procedure for Welding or Cutting Containers That Have Held Combustibles.

In addition to the above, new Committees have been authorized on the following subjects:

Non-Destructive Tests.
Code for the Welding of High Alloy Engineering Structures.
Code for Nickel Alloy Structures.
Committee on Grouping of Materials According to Weldability and to Recommend Standard Practice in Application of Standard Qualification Procedure.

Cooperation of American Welding Society with Other Organizations

American Standards Association

Committee A-10—Safety Code for Construction Work

Our representative in collaboration with various interests has prepared a section dealing with demolition of buildings with particular reference to oxyacetylene cutting. This representative is also covering the section on welding. Material relating to the oxyacetylene process in regard to safe practice has been issued by the International Acetylene Association. Corresponding material on arc welding will be prepared.

Committee A-57—Building Code Requirements for Iron and Steel

During the year 1939, Committee A-57 recommended favorably to the Correlating Committee of the A. S. A. the inclusion of references in its general Building Code to the two AMERICAN WELDING SOCIETY Codes used in building construction, namely, Code 1, Part A, Code for Fusion Welding and Gas Cutting in Building Construction; and Code 2, Code for Resistance Welding of Structural Steel in Building Construction.

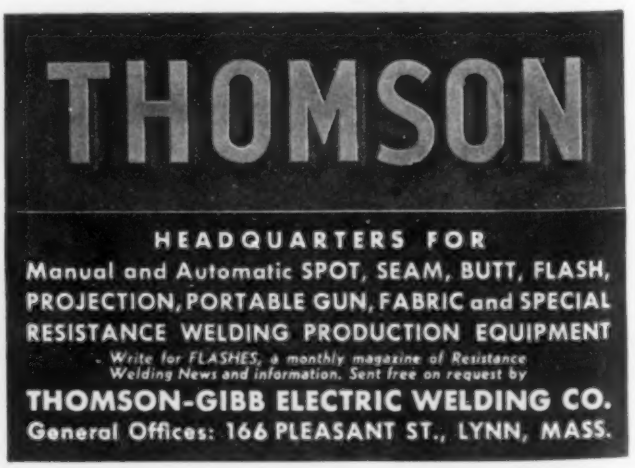
With this action, any Code ultimately issued by the Correlating Committee will contain references to the two A. W. S. Codes mentioned above, thus facilitating the adoption of these Codes as standards by municipal, state and other regulatory bodies.

Committee B-5—Small Tools and Machine Tool Elements

Although this Committee has been very active and has completed 12 American Standards, no direct reference is made to welding. Our representative is in touch with the situation.

Committee B-31—Code for Pressure Piping

At the last meeting of the Sectional Committee, held in New York, N. Y., on Dec. 6, 1938, each of the subcommittees reported satisfactory progress in the revision of the particular sections of the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Code assigned to them. The Subgroup on Welding has completed a draft of the proposed chapter on welding and has distributed it to all members of the subgroup and to a considerable number of individuals outside the subgroup, for the purpose of obtaining further criticisms.

Committee C-42—Definitions of Electrical Terms

The work of this Committee is reaching the stage where it is hoped that during the coming winter it will be possible to issue as an American Standard the first edition of Definitions of Electrical Terms, covering over 6000 terms.

Committee C-52—Electric Welding Apparatus

This Committee has been inactive for a considerable period of time and it is well recognized that the existing standards covering electric arc welding and electric resistance welding apparatus require revision. At the suggestion of the chairman of the Committee, Mr. F. M. Farmer, discussions have been under way looking toward the possible change of sponsor for the work from the A. I. E. E. and N. E. M. A. to the AMERICAN WELDING SOCIETY.

Committee Z-2—Code for Protection of Heads, Eyes and Respiratory Organs of Industrial Workers

The sectional committee for this project just completed a revision of the code which was approved by the A. S. A. late in 1938 as American Standard.

Committee Z-5—Ventilation Code

The Committee is in process of reorganization. It should be pointed out that the work of this Committee will be of great importance to the Society on account of the increasing claims of unhealthful conditions for welding operators as a result of fumes produced by the welding. The scope of the work will be broad enough to cover dust hazards and industrial ventilation, so that the question of fumes from welding operations will no doubt receive consideration.

Committee Z-14—Drawings and Drafting Room Practice

This committee has completed two American Standards; one on Drawings and Drafting Room Practice—Z14.1–1935 and one on Graphical Symbols—Z14.2–1935.

Committee Z-28—Work in Compressed Air

The development of the proposed Safety Code for Work in Compressed Air has been held in abeyance, pending completion of tests and research on decompression rates by the U. S. Navy Department and the U. S. Public Health Service.

Committee Z-32—Graphical Symbols and Abbreviations for Use on Drawings

The A. S. A. Sectional Committee on Graphical Symbols and Abbreviations for Use on Drawings has a number of subcommittees at work on various assignments.

The Subcommittee on Symbols for Welding is identical with the AMERICAN WELDING SOCIETY Committee for Symbols. The Society standard symbols have been submitted to the A. S. A. and it is hoped will be adopted as American Standards.

American Society for Testing Materials

Committee A1—Subcommittee XXI

The AMERICAN WELDING SOCIETY has cooperated with Subcommittee XXI in the preparation of Joint Filler Metal Specifications. The specification issued jointly by the two societies is now in process of revision. It is expected that the portion relating to electrodes will soon be approved by the AMERICAN WELDING SOCIETY and the American Society for Testing Materials. This will serve as a pattern for similar specifications for gas welding and later on for specifications covering other materials than plain carbon and low alloy steels.

Committee B5—Subcommittee on Copper and Copper Alloys

The Committee has been very active during the year working on specifications on (*a*) silicon copper sheets, (*b*) leaded brass sheet and strip, (*c*) copper-nickel-zinc, (*d*) copper-nickel and (*e*) copper tubes and pipes for various purposes.

Association of American Railroads

Committee on Fusion Welded Tank-Car Tanks

Our representative has not been called upon during the year.

American Institute of Electrical Engineers

Subcommittee on Power Supply for Welding Operations

Its purpose is the cooperation and mutual education of electric resistance welding machine manufacturers, users of resistance welding equipment, and power companies, so that the problems involved in installing resistance welding equipment will be intelligently and satisfactorily solved. As a part of this work, the Committee is preparing a bulletin which is entitled, "Guide to Good Electrical Performance of Resistance Welding Machines." This bulletin will be of help to purchasers of resistance welding equipment in that it will help them obtain machines of the best electrical characteristics, and it will also help them to cooperate with the power companies in the matter of providing satisfactory power supply.

National Board of Boiler and Pressure Vessel Inspectors

The Executive Committee of this organization, on which our representative holds membership, has held nine meetings during the past year which were usually concurrent with meetings of the A. S. M. E. Boiler Code Committee. In cooperation with the latter Committee the National Board takes an active interest in the administrative questions connected with boiler and pressure vessel legislation in the various states. The National Board devotes its major attention to the question of uniformity of application of the rules recommended by the Boiler Code Committee and, as a result of its activities, has extended the application of the rules to twenty-three of the states of the nation.

At the present time many problems are arising in the Boiler Code Committee in connection with the extension of the use of welding for both construction and repair purposes. There has been a tendency in some states to frown upon applications of

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fusion welding particularly for repair purposes, and this problem is being given concentrated attention. Marked advances have been made during the year in expanding the permission for such work and further improvements are looked for during the ensuing year.

American Transit Association

Way and Structures Committee No. 3 on Welding

Our representative is cooperating in the preparation of the A. T. A. Filler Metal Specifications.

American Society for Metals

The AMERICAN WELDING SOCIETY has a representative on the Recommended Practice Committee which is concerned with the preparation of a Handbook of the American Society for Metals. This Handbook was issued around the first of the year. Our representative assisted in the editing of various articles, and in the preparation of materials relating to stainless chrome irons and steels and chrome nickel steels.

American Petroleum Institute

Subcommittee on Field Welding of Casing

During the mid-year meeting in New Orleans four very good papers were presented at the group session, May 28th, as follows:

1. "Temperature Determinations in the Cooling Beads of Arc Welds in Steel Casing," by Mr. W. A. Bruce, Carter Oil Company
2. "Critical-Temperature Ranges of Steel by the Dilatometer Method," by Mr. L. H. Winkler, Bethlehem Steel Company.
3. "The Weldability of Casing Steels," by Mr. S. L. Hoyt, A. O. Smith Corporation.
4. "Application of Critical Data in the Field Welding of Casing," by Mr. L. R. Hodell, Carter Oil Company.

FLAME CLEANING AND DEHYDRATING

"Flame Cleaning and Dehydrating," an 8-page illustrated booklet just issued by the Air Reduction Sales Company, discusses the use of this process to halt deterioration of old steel structures by means of paint burning and surface conditioning.

Commenting briefly on the features of the process, the bulletin also shows how, by eliminating moisture from the surface and by cleaning the structure right down to bare metal where possible, the Airco flame cleaning and dehydrating process greatly retards paint lift and surface oxidation. Structures thus treated recently, including the Golden Gate Bridge over the bay at San Francisco, are said to have been remarkably successful.

Other sections of the booklet include apparatus, procedure of operation, regulation of speeds and suggested specifications for various surfaces of metal. Copies of this booklet may be obtained by writing Air Reduction Sales Company, 60 East 42nd Street, New York, N. Y.

KEYNOTE ADDRESS 20th MEETING OF THE AMERICAN WELDING SOCIETY OCTOBER 23, 1939

By Mr. D. Levinger*

I greatly appreciate the privilege extended to me by your committee to say a few words of greeting as you convene this week for your twentieth annual meeting. The industries, scientists and engineers of this great industrial center I am sure will enjoy your presence here and profit from your deliberations and I hope, too, will give generously to your discussions. The beginning of such a program as yours hardly calls for a keynote address, being in itself a keynote in the march of engineering progress. I dare say no industry will avoid the touch of your work. I wonder whether a society has ever before made so important a place for itself in such a comparatively short period of existence.

The art of welding is not long out of that practical period through which most new arts have had to struggle while scientists strove to catch up and reveal the laws and principles which gave understanding and scientific basis to the new way. It is interesting that you have only recently been able to publish a handbook before much of the information was obsolete.

The welding of metals is far reaching indeed in its contribution to the "motif" of our time, more and better products to more people at continually lower cost. I recall my own experience not quite thirty years ago as a witness to the sketches of the inventor, now a prominent industrialist, of machines for automatically blanking and welding precious metal contacts to springs used in telephone apparatus to replace rivets of platinum alloys. It will not be difficult for you to visualize the enormous savings which have accrued through welding a thin disk of the desired thickness of this precious metal instead of making a rivet and inserting it in a hole in the spring in numbers mounting to over a hundred million parts annually.

Since that development other men have developed a composite bimetal ribbon in which a still thinner layer of the precious metal is welded onto a base metal ribbon which is in turn welded to the spring, bringing about still further savings.

You have made great progress in widening the fields of welding applications and processes and machines have been changing at a dizzy pace. No branch of your activity has been neglected. Your materials studies have done much to give confidence to the use of welding as a means of fabricating. Shielded electrodes, welding and brazing alloys, fluxes and more and more applications of non-ferrous materials are some of the results of your increasing development. Welding and

* Asst. to the Vice-Pres. & Works Mgr., Hawthorne Plant, Western Electric Co.

Mr. David Levinger Presents Keynote Address

cutting torches have been made more efficient and their use has been widely extended. Arc welding equipment and methods likewise have been improved to the extent that the most critical pressure vessel welding is entirely predictable in performance. The drudgery accompanying the old hand and foot operated spot welders has been eliminated and multiple projection welding and multihead machines have permitted resistance welding to keep pace with production demands. More examples could be cited and much could be said about the automatic machines and simplified processes which have come out of your new art.

The importance of research and education one would expect your Society to recognize and support with all your vigor. I understand that recent figures show that forty-nine schools were each carrying on from one to a dozen lines of research in welding; some toward undergraduate degrees and others toward advanced degrees.

Welding did not, however, attain its full recognition as a separate branch of Engineering until Ohio State recently announced the curriculum of a course leading to a degree in Welding Engineering. This very noteworthy event is sure to be followed by others.

To consider the part that research has played in Welding progress we must view the field broadly. To the investigations directed at specific welding problems, we must add the vast research aimed in other directions, which in many cases advanced welding also. It was rather a broad jump from the small electronic tube conducting micro or milliamperes to the pool type tube carrying thousands of amperes for a resistance welder, yet research in the electronic field made possible one of the great advances in resistance welding; the electronic timer and the electronic switch. A hospital and a boiler-shop are not ordinarily considered as parallel subjects for research, yet beside the high-powered X-ray of the medical man we have the X-ray for the pressure vessel fabrication to insure safety at pressures and temperatures only dreamed of a short time ago.

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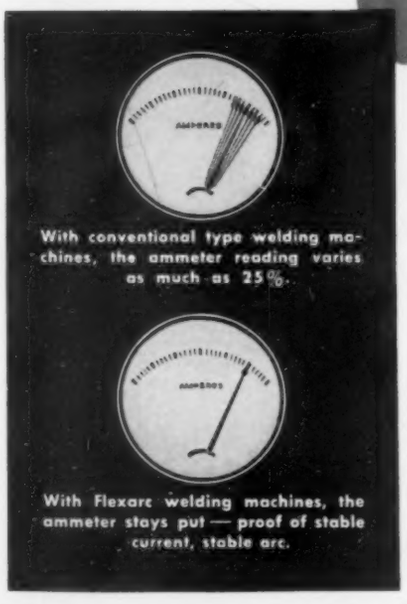
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The commercial aspects of these aids and accomplishments are well known, but there are other phases that are pleasant for the engineer to contemplate. One is the fact that welding has done so much toward making this world a better and more pleasant one to live in. The terrific noise of the riveters gun is disappearing from the streets, and rail and road travel have not only been speeded up, but have been made more comfortable, more economical and safer.

Welding has entered also upon the esthetic side of our lives, as demonstrated by the decorative metal work at the World's Fairs. From what we have seen it appears that the sculptor of the future will be skillful with welding tools as well as with the chisel and mallet.

All of these things and many more (as well as the program for this meeting) indicate how aware you are of the importance of research. I am sure it is safe for me to assume that you are no less aware of the growing social consciousness developing in these unsettled times as well as the impact of the work of the scientist and engineer upon the problems of society which relate to the well-being of the worker. One reads a great deal in current literature about the responsibility of the engineer in public matters, with considerable uncertainty as to how he may properly acquit himself of this responsibility. That he has such a responsibility I think must be granted. It seems to me that Welding Engineers may have particular reason to be sure they prepare to carry their share of the burden of social responsibility, whatever that burden may be found to be. These last ten years have seen the new social thinking carry us far in new economic and social patterns and it is probable that in this same ten year period your Society has seen the greatest progress in Welding and its effect on both the worker and the public.

I shall close my remarks of greeting and good wishes with this very brief reminder that engineers may soon be, and in my opinion should be, called upon to take a more prominent part in the problems of society, and I commend for your reading the last chapter in a new book by Waldemar Kaemppert, "Science Today and Tomorrow" in which he says "The greatest of all inventions will be the social invention that will make the most of science and technology socially in terms of human happiness."

A. S. M. E. ANNUAL MEETING

Dedicated to the peaceful purpose of "broadening the usefulness of the mechanical-engineering profession," the 60th Annual Meeting of The American Society of Mechanical Engineers, a national institution of 15,000 mechanical engineers to be held in Philadelphia at The Bellevue-Stratford Hotel, Dec. 4–8, 1939, is the first annual meeting of the Society to be conducted outside of New York City since 1890, and the first national meeting in Philadelphia since 1887. A General Committee, composed of Philadelphians and headed by Nevin E. Funk, vice-president of the Philadelphia Electric Company, is now completing final plans for the meeting, including technical sessions, social functions, business meeting, inspection trips, college reunions, and a photographic exhibit.

Every mechanical engineer and industrial executive, no matter what his specialized field, will find something of professional interest in one or more of the 103 papers to be presented at 34 simultaneous sessions which are scheduled during the week of the meeting. The chairman of the Technical Events Committee, J. J. McCarthy, reports that those who cannot get away from their business during the daytime can attend one of the five simultaneous technical sessions, covering the topics of work standardization, motion economy in machine-shop practice, aeronautics, elasticity, and domestic fuels, which are planned for Monday evening, Dec. 4th. Other subjects to be discussed, as shown in the technical program which follows, are fuels, photoelasticity, scientific analysis of managerial problems, machine design, iron and steel power, dynamics, industrial marketing, education and training, rubber and plastics, textiles, heat transfer, lubrication, railroads, materials handling, and thermodynamics.

INCREASES BALL PARK SEATING CAPACITY

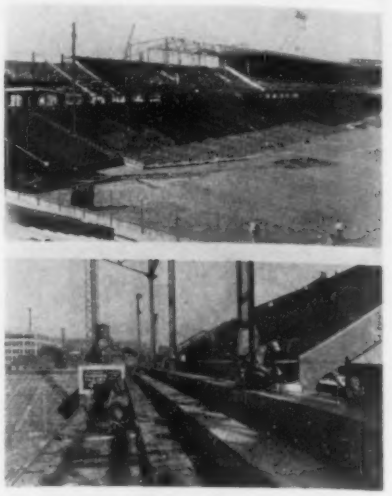
Increasing the capacity of Crosley Field, home grounds of the Cincinnati "Reds," in time for the World Series, and without any interruption to play was made possible by means of arc welding.

The arc-welding process permits fast steel erection without use of auxiliary connecting members. Because of its silent operation there is no noise interference to players or spectators. Knowledge of this advantage prompted the management of the Cincinnati club to employ the modern process rather than conventional methods.

The seating capacity was increased by 3100, providing accommodations for 31,600. The work, involving a new grandstand section in both right and left fields, required 400 tons of steel, supplied by Virginia Bridge Company. The original roof on each of the pavilions was removed, the new second deck erected and then the original roof was replaced over the second deck. Arc welding was used to join all seating decks, to weld all steps, runways and platforms, and join the new decking and columns to the grandstand proper.

Speed of steel erection by arc welding is indicated by the comparatively short time required for the Crosley job. Actual welding began September 5th and the right field section was completed the week of September 25th.

Fig. 1—At Cincinnati, Ohio, Where Additional Seating Capacity Was Provided at Crosley Field in Anticipation of World Series Crowds



Photos courtesy Lincoln Electric Co.

Fig. 2—Modern "Steel Carpenter," (the Arc Welder) "Stitches" Seat Decks Together at Crosley Field to Increase the Seating Capacity

The architects were Harry Hake and Harry Hake, Jr., and the erectors, The J. F. Harig Company of Cincinnati, Ohio.

ENGINEERING MATERIALS

Engineering Materials, by Alfred H. White, Professor of Chemical Engineering and Chairman of the Department of Chemical and Metallurgical Engineering, University of Michigan.

The engineer of today is faced with a bewildering variety of materials which he must use in his work. The simple conception of steel held by a past generation has been complicated by considerations of grain size, hardenability and heat-treatment, and the many varieties of alloy steels have multiplied the materials that are available. The plain portland cement of a few years ago has been split into several specialized varieties. The old white lead and linseed oil have been supplemented by new products that refuse to fall into older classifications. Light alloys and plastics have provided entirely new types of materials. The boiler plant seems to demand the ministrations of a dietitian rather than a brawny stoker.

These advances have been due to intensive research on the part of consumers and producers alike. The structure of our knowledge is still far from complete, but the foundations are sufficiently visible to permit a survey of properties as a function of internal structure.

The present book is intended primarily as a text for all engineering students who have had the usual course in freshman chemistry. It is hoped that practicing engineers may also be interested in a systematic presentation of recent advances in the field of materials.

This book of 547 pages with 200 illustrations is published by the McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, and sells for $4.50.

Wide Use ~ INDICATES QUALITY!

CHAMPION Welding Electrodes are made to the most exacting standards of which we know. Since 1895 we have been manufacturing products from steel — realizing the premium industry places on a quality product, our Research Laboratories are constantly on guard to maintain the high standard of our CHAMPION Welding Electrodes. To further insure our customers of a uniform quality product, we recently adopted a heavy corrugated cardboard shipping container which is sealed on all sides, and there is imbedded in the cover a wire with a loop to facilitate easy opening. Try CHAMPION Red Devil, Blue Devil, Gray Devil or Black Devil Electrodes — there is a type to meet your exacting requirements. Send for descriptive folder.

THE CHAMPION RIVET COMPANY

CLEVELAND, OHIO EAST CHICAGO, INDIANA

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

SPOT WELDING TIMER

Announcement of a new low cost combination weld timer and contactor to provide positive weld timing control for virtually any manually operated 1 to 15 KVA spot welder and capable of such accuracy as to permit the welding of even stainless steel, aluminum or brass with such equipment, is announced by Weltronic Corporation, 2832 East Grand Blvd., Detroit, Michigan.

Available for either 110, 220 or 440 voltages and 25, 50 or 60 cycle frequencies, the new timer-contactor unit, known as "Model 90-53" is adjustable in one cycle steps over the standard 1 to 60 cycle timing range.

NEW UNIVERSAL CUTTING TORCH HOLDER

The modern procedures of flame cutting and flame machining require a wide range of angular torch adjustments. To facilitate ease of adjusting the machine-cutting torch to all horizontal and vertical positions, Victor Equipment Company, 844–50 Folsom Street, San Francisco, have designed and are now producing a machine-cutting torch-holding member with a large ball and socket joint which will permit the torch to be clamped in an unlimited number of required angles. The conventional ratchet type vertical adjustment is actuated by a large and convenient hand wheel. This new adjustable machine-cutting torch-holding device may be fitted on to virtually all standard types of automatic torch guiding machines as well as on to lathe tool holders for flame machining.

101 WELDING IDEAS

A new bulletin, "101 Welding Ideas for Low-Cost Maintenance," which illustrates and describes a wide variety of money-saving repair, fabrication and structural applications of arc welding, has just been published by The Lincoln Electric Company, Cleveland, Ohio.

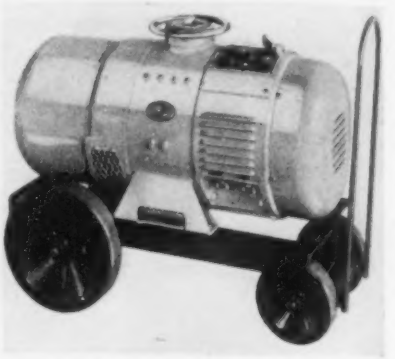
SPOT-WELDING GUN

Unique combination of a light weight hydraulic spot-welding gun and light weight current-carrying extension arm of aluminum has simplified the problem of spot welding in relatively inaccessible locations such as the four long inside seams on circulator heater cabinets. As shown, the entire length of each seam can be easily welded in one continuous operation. Designed and built by Progressive Welder Company, 737 Piquette Avenue, Detroit, Michigan, the equipment consists of an hydraulically operated spot-welding gun mounted on one end of an extension handle. Each of the two aluminum sections which comprise the handle conduct the current from the single bolt cable connection at the input end to a similar, single bolt connection at the gun end. In addition to carrying the welding current, each extension handle element is of hollow section to permit supply and return of water for cooling the gun and welding points. Hydraulic pressure supply to the pressure cylinder on the gun is carried in a flexible hose, along the top of the handle. Push button control at the operator's end of the unit is in the form of a handle for easy manipulation of the unit.

(Upper) Welding Gun Mounted on Current-Carrying Extension Handle Is Placed in Welding Position for Continuous Spot Welding of Inside Seam of Circulating Heater Cabinet. (Lower) Trolley Wheel, Riding on Edge of Seam, Facilitates Control and Locating of Welding Gun When Making Spots Near the End of the Seam

ARC WELDER DEVICE

A new single operator motor-generator arc welder, requiring only one control device for operation, has just been announced by Wilson Welder and Metals Company, Inc., 60 East 42nd Street, New York, N. Y.



Known as the Wilson "Hornet," this welding machine employs for its control a single, simple handwheel located on top of the unit. Adjustment of this handwheel permits the operator to obtain an infinite number of current settings. Dial markings are so accurately calibrated that meters are not required.

Single-pole control design assures a current output that will not vary, resulting in a constant, uniform arc at all times. Accidental reversal of polarity is impossible because the electric current is so designed that a small snap switch must be flicked by the operator to change the polarity.

PRESSURE BLOWER

A distinct innovation in blower construction is exhibited by the new Sawyer Master Pressure Blower which was designed primarily for exhausting toxic fumes from welding operations where space is at a premium and an advantage lies in exhausting through a hose rather than directly through the machine. This blower is capable of moving a considerably large quantity of air through hose up to 75 feet in length.

The specially built motor is entirely enclosed and is placed in the intake air housing in such a way that the entire volume of air delivered by the blower passes completely around the motor with resultant efficiency in air cooling.

OPERATORS WILL LIKE

THE NEW

WILSON "HORNET"*

They helped design it

The new Wilson "Hornet" is the answer to what operators all over the country have suggested toward the development of a sturdy arc welding generator. » » » Simple to operate with no delicate parts to get out of order, yet complete in every detail . . . capable of doing any job that comes into the shop . . . output controlled by means of a sturdy handwheel. Maintains a constant arc which leaves the operator free to do what the machine was primarily designed for . . . namely: to make a better weld.

*TRADE MARK

WRITE FOR YOUR COPY
of the new Wilson "Hornet" bulletin featuring the newest of..."the machines that make the arc behave."

WILSON WELDER and METALS CO., INC.

General Offices: 60 East 42nd Street, New York, N. Y.

DISTRIBUTED THROUGH AIR REDUCTION SALES COMPANY'S DISTRICT OFFICES IN PRINCIPAL CITIES

The elimination of brushes, commutators, gears and centrifugal switches simplifies the construction and reduces size, weight and maintenance expense. It is claimed that the Sawyer motor delivers a given horsepower with about half the weight of other motors, and that the power pull-out is twice the rated capacity.

Further information will be supplied by Sawyer Electrical Mfg. Co., 5715 E. Leneve Ave., Los Angeles, California.

WELDING AND CUTTING EQUIPMENT

A number of improvements are featured in the new line of Prest-O-Weld welding and cutting apparatus, recently introduced by The Linde Air Products Company after extensive field tests. This new equipment consists of a welding blowpipe, cutting blowpipe and cutting attachment. All retain the detachable valve body construction, which permits quick changing from welding to cutting, and cutting to welding.

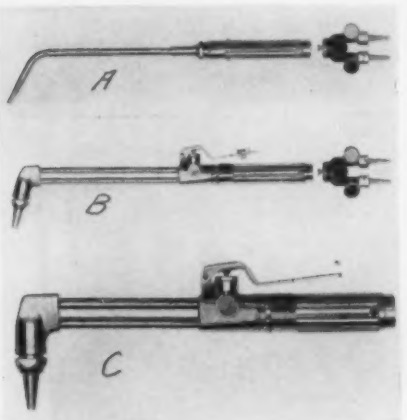
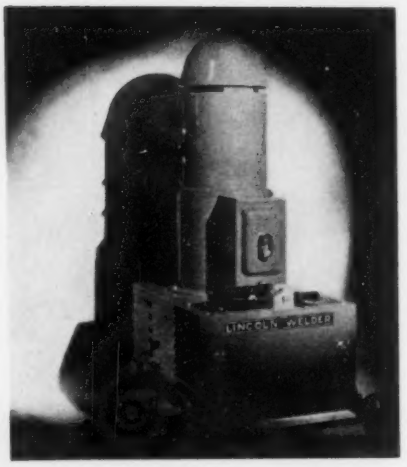


Fig. 1
(A) (Type W-108) Welding Blowpipe
(B) (Type C-108) Cutting Blowpipe
(C) (Type CW-108) Cutting Attachment

Among principal features of the W-108 welding blowpipe are the individual mixers in every head making correct flame adjustment easy, and giving definite resistance to flashback. Both the oxygen and acetylene for this "balanced-pressure" blowpipe may be set at approximately the same pressure in lb. per sq. in. as the number of the head. The welding heads provide a long, slender flame with a well-formed inner cone that permits thorough heating of even the bottom of the vee, and provides good control of the welding puddle. Special heads that confine the flame to a small area are available for welding auto fenders and similar work.

ARC WELDER

A new 200-ampere arc welder of the Lincoln Junior type with a range for many welding applications ordinarily associated with considerably larger welding equipment, is announced by The Lincoln Electric Company, Cleveland, Ohio. This new machine, because it is of motor-generator D.C. arc type, will weld virtually all metals and alloys and do hard-facing work, according to the manufacturer. Its speed of operation and quality of results are reported to be exceptionally high for work of all sizes, under all operating conditions.



The new welder (see cut), is single-operator, variable-voltage type and can be used with either bare or shielded arc type electrodes. It has a current range of 60 to 250 amperes for welding duty.

ALUMINUM FLUX

A new type of flux has been developed for tinning aluminum as well as all other metals, including cast iron. Its low melting point and low price range make it a most practical flux for general work.

"Amco" Aluminum Flux not only dissolves the oxide on the metal to be soldered but at the same time coats it with a metal to which ordinary tin and lead solder will adhere readily. If aluminum solder is to be used, this may be applied to the coated surface without any further preparation and a perfect bond will result. The flux may be used with any clean source of heat as well as with an ordinary soldering copper.

PRINCIPLES OF METALLOGRAPHY

Principles of Metallography, by R. S. Williams and V. O. Homerberg. This book is intended to give to the general reader the fundamentals of Physical Metallurgy and to serve as an introduction to larger and more specialized books. The text has been extensively revised to include new material that has appeared since the previous edition was published. A new chapter on "The Plastic Deformation and Annealing of Metals" has been added.

Greater emphasis has been laid on the applications of Metallography than on the physico-chemical principles involved but it is believed that the fundamental ideas on which metallography is based have not been neglected. In the appendix will be found a few of the tables most commonly used by the metallographist, a suggested outline of a brief laboratory course and a descriptive list of the more important books and journals dealing with the subject.

Published by the McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $3.50.

FACE SHIELD CATALOG

Face Shields is the subject of a new four page catalog just released by the Boyer-Campbell Company, 6540 Antoine St., Detroit—it features seven models and fifteen different numbers, describing in complete detail the right *Face Shield* for the job. Due to complete interchangeability of parts some models may be adjusted to almost every industrial need.

PROPELLER GETS PROTECTION

This unusual close-up shows cobalt-chromium-tungsten hard-facing alloy being applied to a ship's propeller blade. The ship, the "Lord Kelvin," draws an oceanic cable-laying plow designed and used by the Western Union Telegraph Company. Hard-facing the propeller is expected to overcome the effects of cavitation and erosion which are encountered by the propeller blade in its heavy-duty service.

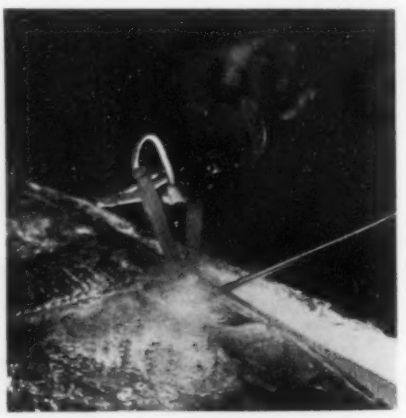
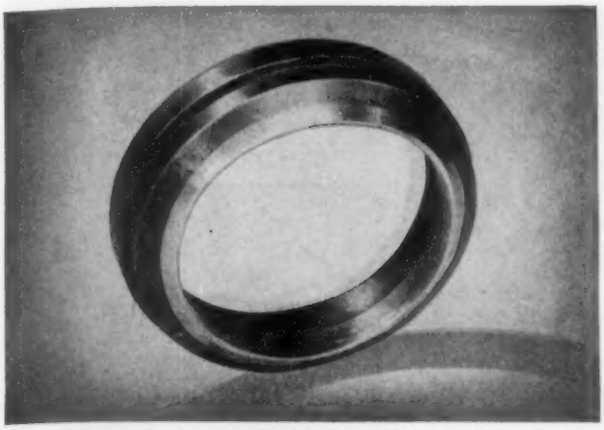


Photo courtesy Haynes Stellite Co.

NOZZLES INCREASE CUTTING PRECISION

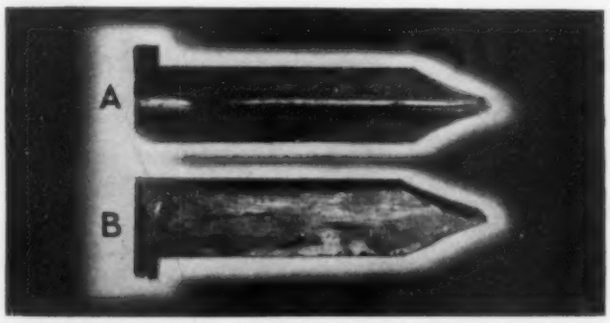
The new Oxweld nozzles are superior to regular cutting nozzles for three reasons. First, the cutting oxygen passage is highly polished, thus producing a smooth gas flow without deflection or turbulence. This results in a clean, unbelievably smooth face of cut. Second, the preheat holes are smaller and spread over a larger circle so that the heat is less concentrated on the line of cut. This results in a squarer,

REDUCE WEAR AND SAVE MONEY
with Haynes Stellite Alloy



METALWORKING—The cutting edge of this shearing die for stamping tin can tops has a layer of Haynes Stellite alloy applied with the oxy-acetylene blowpipe to give it 4 times the life of steel dies not hard-faced.

POWER—This disk and seat for a 16-in. valve, hard-faced with Haynes Stellite alloy by the oxy-acetylene process and ready for finish-grinding, will handle 350,000 lb. of steam per hr. at 400 lb. pressure and 750 deg. F.



STEEL—These rolling mill guides have been used 70 hr. A, of cast iron, must be discarded; B, of low-carbon steel hard-faced with Haynes Stellite alloy by oxy-acetylene welding, will last 400 hr. and can be hard-faced again.

COKE—The life of this cast steel ramhead for a coke discharging machine has been increased from 9 weeks to 59 weeks by the application of a coating of Haynes Stellite alloy to the wearing surface by oxy-acetylene welding.

Write for the 104-page book, "Hard-Facing With Haynes Stellite Products, which shows how these products can reduce wear and save money. There is no obligation.

PRODUCT OF A UNIT OF UCC UNION CARBIDE AND CARBON CORPORATION

"Haynes Stellite" is a registered trade-mark of Haynes Stellite Company.

HAYNES STELLITE TRADE MARK

Red-hard, wear-resisting alloy of cobalt, chromium and tungsten

HAYNES STELLITE COMPANY

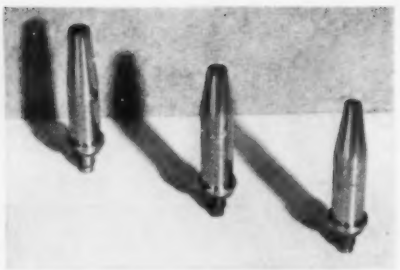
Unit of Union Carbide and Carbon Corporation

UCC

Chicago · Cleveland · Detroit · Houston · Los Angeles · New York · San Francisco · Tulsa

General Office and Works—Kokomo, Indiana
Foreign Sales Department—New York City

Haynes Stellite hard-facing rods and information on other Haynes Stellite Company products also are available through all apparatus shipping points of The Linde Air Products Company



A New Series of Oxweld Precision Cutting Nozzles Will Make Oxyacetylene Machine-Cut Surfaces More Uniformly Smooth

cleaner, sharper upper edge, a smaller kerf, and a saving in preheat gases. Third, the cutting oxygen passage is exactly vertical when the blowpipe is vertical, so that when cutting shapes or circles, the face of the cut is exactly true all around.

RECONSTRUCTION WORK ON VIADUCT

One of Denver's main thoroughfares to the North Side, the 14th Street Viaduct, was closed the early part of this year for the purpose of reconstruction, widening and strengthening the roadbed; made necessary by the constantly increasing traffic.

Originally the viaduct was 35 feet wide, with 7½-foot sidewalks on each side for pedestrian travel. The sidewalks have been reduced to 4 feet on each side, allowing a 42-foot roadbed for motor vehicles. The structure has been greatly strengthened in order to safely carry present-day traffic.

The original roadbed, which was removed, was constructed of quarter-inch steel plates, 4 feet wide by 20 feet long, in which five buckles had been pressed for the purpose of strengthening. These plates had been bolted to the supporting steel beams and the natural concrete base material and asphalt paving applied.

In considering the various methods by which the reconstruction work could best be accomplished, the engineers found that by turning over the old buckle plates—that is, turning the buckles down, thus forming a pocket for the reinforced concrete—the strength could be increased by three times over the old design.

Reconstruction plans also called for the addition of steel "I" beams and angle iron with a combined weight of 280,000 pounds. To add this amount of steel to the old structure by bolting or riveting would necessarily be much more costly than welding, as all holes for connection on the original structure would require drilling. Welding was therefore adopted as the most economical and safe means of making all connections.

All old sections of steel members showing signs of severe corrosion were replaced with new steel. After all the new and replaced steel was welded in, the buckle plates were welded down; their main function being that of providing a form for the reinforced concrete. There was approximately 13,000 feet of vertical and overhead welding of ¼-inch fillet welds and 9,000 feet of horizontal fillets on buckle plates.

Photo courtesy Hendrie and Bolthoff Mfg. and Supply Co.

Operator Running Horizontal Fillet Weld

ANTI-AIRCRAFT COMBAT CAR

Equipped with 3 machine guns and a cannon...capable of traveling more than 100 miles per hour...built of 0.50 caliber bullet-proof armor plate and glass...mounted on bullet-proof tires...able to climb grades of 50% inclination and travel through mud, sand and broken ground...having a cruising range of 225 miles at 70 miles per hour...as easy to drive as a motor car—that, in substance, is the newest type of anti-aircraft combat car.

This new mobile unit (see accompanying illustrations), is a powerful arm of defense against low-flying aircraft on ground-straffing missions. Its armament, speed, maneuverability and bullet-proof construction make it always ready for instant use. It was designed by Preston Tucker of Tucker Manufacturing Co., Ypsilanti, Michigan.

This tank was made possible by use of the most modern steel construction process—arc welding. Arc welded construction actually makes the machine bullet-proof. Welding does away with bolts and rivets which become worse than projectiles when driven into the tank by heavy gun fire. While eliminating this hazard, the arc welds are themselves bullet-proof. They were made with electrodes, developed particularly for arc welding high tensile steels, the tensile strength of the welds being in the neighborhood of 100,000 lb. per sq. in. The design is such that no lap or butt joints are used. The joints are all corner welds or modified at various degrees. The result is homogeneous construction throughout with no vulnerable spots. The body, camouflaged with a special design, is constructed of 0.287 steel in 10 arc-welded sections. The radiator angles

Fig. 1.—"Tucker Tank," Anti-Aircraft Combat Car, Top Speed Over 100 Miles per Hour, Bullet-Proof, Arc-Welded Construction

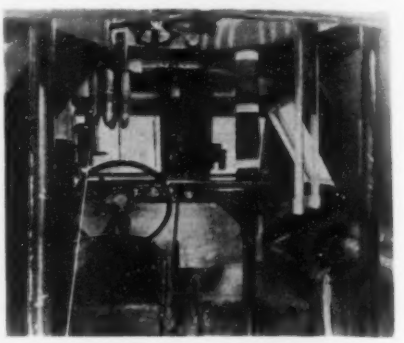


Fig. 2—Inside the "Tucker Tank"

Photos courtesy Lincoln Electric Co.

Fig. 3—Action View of "Tucker Tank"

are so constructed that bullet penetration through that source is impossible.

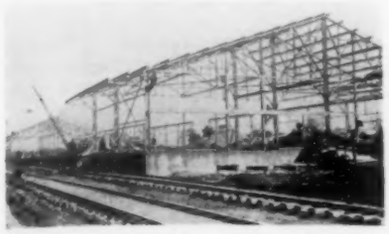
This tank is equipped with one 37 mm. full automatic cannon firing at the rate of 120 shots per minute, and three-30 cal. machine guns firing at the rate of 5100 shots per minute, or a total rate of fire of 5220 shots per minute. The gun mounts are of arc-welded construction. The turret rotates freely giving complete firing range, and all glass is 2½ inches thick and placed so as to give full visibility.

A speed of 114 miles an hour is possible with a 200 hp. motor having a seven speed transmission. In addition, the unit has a 108-inch wheel base and a standard racing car arrangement in springs and chassis.

Radio equipment and compass are contained in the interior which is air conditioned for comfort.

SAVANNAH'S FIRST ALL-WELDED BUILDING

The first all-welded building to be erected in Savannah, Georgia, is the recently completed plant built for National Gypsum Company by the Schieve Construction Company, of Buffalo, N. Y.



(Photo courtesy of Wilson Welder and Metals Co., Inc.)

The building is 1100 feet long, and the welded framework required 1300 tons of structural steel and 5 tons of electrodes. The new plant is to be used for the production of gypsum board.

WINDOWLESS BUILDING

Church & Dwight Co., Inc.'s new air conditioned windowless building—described as "the cleanest plant on earth"—was completed, exactly one year after ground-breaking ceremonies, in Syracuse, N. Y.

Designed and built by The Austin Company, who employed more than 400 men in its construction, this new home of Arm & Hammer Brand and Cow Brand baking soda, charts a new trend in the design of industrial structures.

Windowless Building

Actually Just An Attractive Air-Conditioned Package to Support and Enclose Conveyors, Carbonating Towers and 8-Story Tanks Lined with Stainless Steel, the Plant Has Interior Walls of Glazed Tile and Functional Panels of Glass Block Instead of Windows. Its Entire Framework Was Electrically Welded, as Was Most of the Equipment Required for the New Continuous Process. Produced from Start to Finish in an Enclosed Maze of Equipment, the Bicarbonate of Soda Will Not Even Come in Contact with Air Inside the Plant Until It Is Ready for Packaging

It will operate 24 hours a day and 365 days a year under absolutely uniform atmospheric and temperature conditions.

Offices and laboratories located on the first floor are entirely enclosed by glass block, which suggests the functional layout of the entire plant Vertical panels and tall shafts of glass block admit light to stairways and lofty sections accommodating tanks, one of which fits snugly inside the curved corner.

The entire structure is supported on an all-welded steel framework and its interior walls are glazed tile.

OBITUARY

Herbert Melville Boylston, 58, retired head of the metallurgical department of Case School of Applied Science, Cleveland, died July 28th at his summer home in Massachusetts.

Born and reared in Brooklyn, N. Y., Mr. Boylston attended Harvard University, where he was graduated in 1903 and took a degree in metallurgy in 1905. His first position was as private technical assistant to Dr. Henry Marion Howe where among other duties, he assisted in the revision of Dr. Howe's book, "Iron, Steel and Other Alloys."

In 1906 he became an instructor at Harvard University and taught metallography and metallurgy until 1912 under the late Albert Sauveur, assisting the latter also in consulting practice and in the development and sale of metallographic equipment. In 1912 he became managing partner for the laboratories of Sauveur and Boylston in Cambridge and continued this business until he joined the Case School faculty in 1920. He also conducted the Sauveur and Boylston Correspondence Course in the Metallography and Heat Treatment of Iron and Steel for many years.

Mr. Boylston was the author of a book on iron and steel which has been adopted by a number of American colleges as a text. He also wrote many papers on metallography of iron and steel for the American Institute of Mining and Metallurgical Engineers and the American Society for Metals.

In addition to serving for ten years as the first chairman of the Publication Committee of the American Society for Metals, Professor Boylston took an active part in the work of the American Institute of Mining and Metallurgical Engineers, the American Society for Testing Materials, AMERICAN WELDING SOCIETY, and other technical organizations.

EMPLOYMENT SERVICE BULLETIN

POSITION VACANT

V-91. General Superintendent wanted for large modern welded pressure vessel plant in the southwestern U. S. oil country. Of primary importance is skill in handling men. Should also be familiar with modern arc welding and machine shop practice.

SERVICES AVAILABLE

A-325. Welding Engineer experienced in marine work and production work. Ability to handle men and to turn out quality welding jobs. Thoroughly trained by Lincoln Electric Company. Recently connected with Todd Shipyards as Production Engineer, put plant in shape to handle increased business due to war activity. Converted freighters to tankers for another Drydock company. Production of welded automotive products. Production and repair of special alloy castings. Age 36.

A-326. WANTED. A position where there are opportunities for promotion and advancement after proved ability as an expert welder in either Electric Arc or Oxyacetylene methods. Age 25, perfect physical condition, recently finished a complete course in both Electric Arc and Oxyacetylene Welding at the Milwaukee School of Engineering, Milwaukee, Wis. Member of the AMERICAN WELDING SOCIETY, and can give the best of references.

A-327. Electric Welder. 15 years' experience both at home and abroad on oil field, refinery, railroad, shipyard, mining, tank and boiler work. Will be glad to forward references regarding ability and character to any one interested.

A-328. Welding Engineer, graduate of recognized mechanical engineering college in 1930, experienced nine years in resistance, arc, gas welding and brazing all metals of all sizes and forms, and familiar with welding equipment, tools, supplies and methods, desires change in manufacturing or sales.

A-329. Welding Executive Engineer available. Specialist in precision resistance welding of all kinds with a background of years of practical experience in automotive, aircraft and calculating machinery development. Member of AMERICAN WELDING SOCIETY. Ability to make real contribution to an organization having existing or potential field for welding processes. Location unimportant but would prefer northern or northeastern states.

PROMOTION

Walter H. Bruckner, a member of the staff in the Department of Mining and Metallurgical Engineering, University of Illinois, has been promoted from the position of research associate to research assistant professor in metallurgical engineering, effective September 1, 1939. Office address is 204 Metallurgical Laboratory, Urbana, Illinois.

CREDIT NOTICE

In THE WELDING JOURNAL, September 1939, page 554, there was published an extremely interesting article on the Twin Launching of two Coast Guard Cutters. This article and photographs were furnished us through the courtesy of The Hobart Brothers Company, builders of Arc Welders, Troy, Ohio.

» » » SECTION ACTIVITIES « « «

BIRMINGHAM

At a meeting of the Publicity Committee held on September 1st extensive plans for the coming season were made. A registration and greeting committee for the registration of all guests at meeting and greetings to guests and members on their arrival at meeting place, was appointed. The committee is also charged with the responsibility of providing attendance prize for each meeting. Mr. J. W. Adams, the newly elected Chairman of the Section, was unanimously given the responsibility of writing a letter to a mailing list soliciting new members. Mr. Adams advised the committee that he had arranged with two of the Birmingham papers for ample publicity during the coming season. He further stated that a release regarding the October meeting in Chicago had been given to the News on August 30th, which resulted in creating considerable interest on the part of the local Chamber of Commerce toward inviting the A. W. S. and the Metal Congress to Birmingham for 1941.

At a meeting of the Executive Committee held on September 27th, among other things discussed, it was agreed that a monthly meeting of the Section should be scheduled, at which a regular educational program would be put on. Mr. F. E. McAtee was appointed as the Birmingham representative at the Annual Meeting of the Society in Chicago.

BOSTON

Over 100 attended the opening meeting of the season which was held on October 9th at the Massachusetts Institute of Technology. The meeting was called to order by Chairman Mehaffey, and Mr. F. W. Davis, Chairman of the Meeting & Papers Committee introduced the speakers of the evening.

Professor Arthur L. Townsend, Massachusetts Institute of Technology, gave an interesting paper on the history of welding starting with the earliest recorded instances of gas and electric welding, and outlining the various steps of development up to recent years.

Mr. Everett Chapman, President of Lukenweld Inc., discussed the design of fabricated structures, illustrating his points with lantern slides. At the conclusion of his formal discussion of the subject, the meeting was opened for a question and answer period. This lasted an hour and was a continuation of the subject of design.

This Section meets on November 13th at the New England Welding Laboratories Inc., 88 St. Stephen Street, Boston, to hear Mr. J. G. Magrath of the Air Reduction Sales Company talk about "Flame Hardening," to see a demonstration of Flame Hardening, and to hear Mr. L. T. Gibbs of the General Electric Company discuss the "Qualification of Welders."

At the conclusion of this meeting, there will be an inspection of the New England Welding Laboratories.

CENTRAL PENNSYLVANIA

On Wednesday evening, October 4th, the Central Pennsylvania Section was officially launched. One hundred and six men turned out for this organization meeting and be fore the evening was over the Section was able to boast of a membership numbering 52.

John W. Hennessey, acting as temporary chairman, presided and gave a brief outline of the activities leading up to the formation of this Section. He was followed by Mr. H. C. Boardman, President of the Society, who outlined for those present the advantages of being connected with the Society.

The welding subject was "The Field Erection of Welded Tanks," presented by Mr. Boardman, who is Research Engineer of the Chicago Bridge and Iron Company. Mr. Boardman's presentation was most interesting and educational. It was followed by a lively discussion.

In so far as this Section was organized in such a short period of time no officers were elected at this first meeting. A nominating committee was appointed to present a slate of officers at the next meeting.

CHICAGO

At the regular monthly meeting of the Chicago Section held on September 15th in the Chicago Lighting Institute, Mr. W. A. Miller of the Hartford Steam Boiler Inspection and Insurance Co., spoke on the subject "What an Insurance Company Expects in Insured Weldments."

The Chicago Section has worked diligently with Society headquarters in the preparation of plans for the Annual Meeting of the Society which was held in Chicago during the week of October 22nd. Due in a large measure to the Section's untiring efforts, the 20th Annual Meeting was one of the most successful held in the history of the Society. Novel entertainment in the way of singing by the Purdue University Glee Club of 40 voices and music by Don Fernando's Orchestra, with Mr. Nathaniel Leverone, Pres., Automatic Canteen Company of America, as Toastmaster, were a few of the features at the Annual Banquet arranged by the Entertainment Committee of the Chicago Section. The keynote speaker at the opening session was Mr. David Levinger, Asst. to the Vice-Pres. & Works Mgr., Hawthorne Plant, Western Electric Co. The speaker at the Banquet was Dr. Ovid W. Eschbach, Dean, Institute of Technology, Northwestern University. The technical sessions and other meetings were also ably handled by local committees of the Chicago Section.

CINCINNATI

The open meeting of the Cincinnati Section was held September 13th at the Engineers' Club at which time Mr. J. H. Deppeler, Chief Engineer and Works Manager of Metal & Thermit Corporation, spoke on "Welding Electrodes and Their Use and Thermit Welding."

The following are the meetings scheduled up to January 1, 1940:

October 12, 1939—8 P. M., "Resistance Welding"
November 8, 1939—"Welding Cost"
December 13, 1939—"Distortion Problems in Welding"

The respective speakers who will deliver the above subjects are from the General Electric Company, The Lincoln Electric Company and Westinghouse Elec. & Mfg. Company, which assures an excellent program for the balance of the year.

CLEVELAND

A series of six lectures starting on October 16th will be given by the Cleveland Section by Mr. Walter E. Davis, Welding Engineer, Cleveland Railway Company. The program for these lectures was given in the October Section Activities.

The program for the regular meetings of the Cleveland Section for the coming season is given below:

November 8th—Fenn College, 8:00 P. M., "Destructive and Non-destructive Testing of Welds on High Pressure Piping and the Hardfacing of Steam Valves," by Eric Seabloom.

December 13th—Cleveland Club, Dinner meeting; dinner 6:30, meeting 8:00. "Welding in the Manufacture of Railroad Cars," by J. M. Unger.

January 10, 1940—Fenn College, 8:00 P. M., "Manufacture of Process Machinery by Arc and Hammer Welding and Gas Cutting," by E. W. Forker.

February 14, 1940—Dinner meeting, Cleveland Club; dinner 6:30, meeting 8:00. "Assembly Plant for the Mass Production of Welded Barges and Other Structures," by George Wolf.

March 13, 1940—Fenn College, 8:00 P. M. "Welding of Large Steam Shovels," by H. L. Rogers.

April 10, 1940—Dinner meeting, Cleveland Club; dinner 6:30; meeting 8:00. "Welding Requirements of the A. S. M. E. Power Boiler and Unfired Pressure Vessel Codes and the Qualification of Welding Operators," by W. D. Halsey.

TO THE MEMORY OF

Samuel Wylie Miller

This page is

Dedicated

by the

Electric Arc Cutting and Welding Company

In recognition of the award of the

Samuel Wylie Miller Memorial Medal

of the

American Welding Society

to our President

CLAUDE J. HOLSLAG

ELECTRIC ARC CUTTING AND WELDING CO.

152 TO 162 JELLIFF AVENUE, NEWARK, NEW JERSEY

May 8, 1940—Fenn College, 8:00 P. M. "Economic Production of Heavy Mechanical Equipment by Use of Welding and Cutting," by George Jessop.

COLORADO

The regular meeting of the Colorado Section was held on October 11th at the Public Service Company Auditorium, Denver. Mr. H. W. Creager, Secretary of the Section led a lively discussion on "Penetration and the Effect on Penetration by Voltage and Current Control.

COLUMBUS

The Columbus Section meets on the second Friday of the month from September through May. The following is the program for the coming season:

November—Film "The Making of Alloy Steels," by R. A. Stitt, Ohio State University and Bethlehem Steel Co.

December—"Procedure Control," by H. C. Boardman, Chicago Bridge and Iron Co.

January—"Mobile Artillery Developments," by Col. N. F. Ramsey, Rock Island Arsenal

February—"Boiler and Insurance Standards," by T. M. Jasper, A. O. Smith Corp.

March—"Spot and Resistance Welding," by J. D. Gordon, Taylor Winfield Corporation (Tentative)

April—American Brass Co. film "The Story of Anaconda."

May—Descriptive talk by Mr. Hoyt and a tour of the Battelle Memorial Institute.

DETROIT

The Detroit Section announces the appointment of the following committees to function during the 1939-1940 season:

Program: D. H. Corey, Chairman; L. M. Benkert, Wm. M. Hayes and J. B. Manor.

Membership: L. H. Frost, Chairman; S. M. Harvey, Vice-Chairman; Walter Anderson, Julius Brueckner, C. Collum, Paul Dodge, G. F. Friebel, A. E. Hackett, W. M. Hayes, H. A. Jackson, J. W. Keyes, S. F. Maire, J. B. Manor, Vaughan Reid, E. J. Rousseau, G. N. Sieger, W. H. Simmons, E. C. Stone, W. J. White, and Fred Wirth.

Friendship: Russell W. Brendle, Chairman; C. L. Eksergian, Joseph Matte, Jr., and Cal Weihe.

Publicity: William F. Sherman.

At the October 6th meeting held at the Detroit-Leland Hotel, Mr. A. E. Hackett, of the Progressive Welder Co., gave a very interesting résumé of the early history of spot welding. Mr. L. M. Benkert of the same company showed slides and pictures of the work which has been done on heavy plate spot welding. There was an attendance of approximately 100 at this meeting and it appears as if the Detroit Section is going to have a very successful season.

GEORGIA

The Georgia Section held its regular monthly meeting at the Piedmont Hotel on September 11th. There was no special program or principal speaker due to the installation of new officers, appointing chairmen of committees and planning for the coming year.

After the installation of officers, a general discussion on programs for the coming year took place. Several good suggestions were made.

The following are the officers and committee chairmen appointed:

Chairman—D. B. Hunt

Vice-Chairman—A. M. McCoy

Secretary-Treasurer—H. J. Lee

Executive Committee Chairman—C. R. Bloxton

Program Committee Chairman—E. R. Harrison

Publicity Committee Chairman—M. C. Snead

Membership Committee Chairman—E. Gill

The regular monthly meeting of the Georgia Chapter of the AMERICAN WELDING SOCIETY was held on October 2nd at the Piedmont Hotel in Atlanta, Ga. Dinner was served at six thirty P.M. and the meeting was called to order by the chairman, Mr. D. B. Hunt, at seven thirty P.M.

The meeting for November was discussed and planned, the Program Planning Committee Chairman, Mr. E. R. Harrison, gave a general outline of the next meeting and every one highly approved of his plans.

The guest speaker for the meeting was Mr. L. B. Ely, Manager of Process Service for The Linde Air Products Company at Birmingham, Alabama.

Mr. Ely gave a brief preview of the movies he had to be shown on the Unionmelt Electric Welding Process. After the movies were shown, which were interesting, Mr. Ely had an informal discussion on the Unionmelt Process. All questions were answered and discussed thoroughly by Mr. Ely.

LOS ANGELES

The Executive Committee of the Los Angeles Section met on Monday evening, September 18th. A Resistance Welding Committee was appointed for the purpose of creating interest in this branch of the trade, and to assist in formulating programs on this topic for the ensuing year. Mr. L. D. Kennon is Chairman of this committee. It was decided that a Social Christmas party should be held again this year, and the Entertainment Committee should work out the details. It was decided to sponsor an Educational Course starting the latter part of January or the early part of February, 1940. Alex Maradudin, Chairman of the Educational Committee, was appointed to draw up a draft with suggestions and recommendations as to the topic of this course.

MARYLAND

The following are the subjects and speakers for coming meetings of the Maryland Section.

November 17th—Distortion of Welded Structures, by Charles Jennings.

January 19, 1940—Procedure of Welding, by Mr. Fitzgerald.

February 16, 1940—Mr. Boardman.

March 15, 1940—Welding of High-Pressure Pipe. Mr. Basil Osmin will supply speaker.

April 19, 1940—Roy Mansfield will supply speaker on the manufacture of Bronze Alloy and Welding Rod, and Welding Procedure.

Sometime in December 1939 there will be a tour through the Bethlehem Steel Plant, Sparrows Point, Md.

MILWAUKEE

The first meeting of the 1939-1940 season of the Milwaukee Section was held on Friday, September 29th at the City Club of Milwaukee. Dinner preceded the meeting. An after dinner talk was made by Stoney McGlynn, Chief Sports Writer of Milwaukee Sentinel, who spoke on "Highlights in Sports." The welding address was given by Mr. Elmer Isgren, Plant Superintendent, R. G. LeTourneau, Inc., on "Arc Welding Road Equipment." The meeting was followed by an informal get-together. Refreshments and a buffet lunch were served.

The October meeting was held on the 20th. An after dinner talk was presented by Mr. Carl H. Franke of Eastman Kodak Company. The welding address was made by Mr. Stephen Smith, Development Engineer of Air Reduction Sales Company.

NORTHERN NEW YORK

The Northern New York Section held its first meeting of the year at the Stanley Club, Pittsfield, Mass., on Tuesday, September 26th. Following the dinner, the group was addressed by Dr. W. G. Theisinger, Welding and Metallurgical Engineer for the Lukens Steel Company who spoke on the "Heat Effect in Welding." Dr. Theisinger also discussed personal observations and problems experienced on the Grand Coulee Dam project and showed a welding film "Heat and Mechanical Stress in Welding." The attendance was 82.

NORTHWEST

If the first two meetings of the Section this season are typical of those that are to follow, the Northwest Section is promised a most interesting and successful year.

On September 19th, K. L. Hansen, consulting engineer, Harnischfeger Corporation, Milwaukee, Wisconsin, presented a most interesting paper on "Electric Arc as a Welding Tool."

The October meeting on the 10th was a double header, the speakers being C. E. Morgan, superintendent of work equipment and welding, Chicago, Milwaukee, St. Paul and Pacific Railroad Company, Chicago, who spoke on "Maintenance of Way Welding," and F. B. Doan, vice-president, Magnaflux Corporation, Chicago, who spoke on "Magnaflux Inspection of Welds," illustrated by lantern slides. Both discussions brought out many important points in the subjects, which supplied valuable information to all present.

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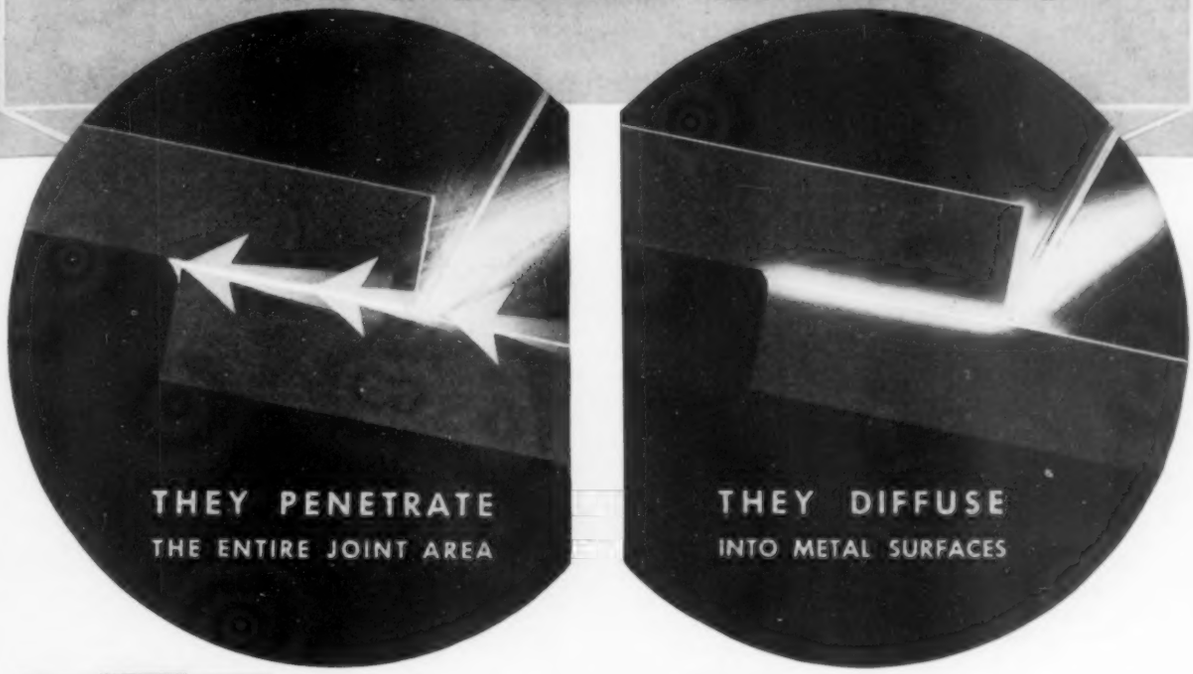

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SIL-FOS and EASY-FLO brazed joints are stronger than the metals joined. Under breaking tests the metals joined give way—not the joints.

DUCTILITY

Bend, twist, hammer and pound SIL-FOS or EASY-FLO joints—the silver in them makes ductile joints that are practically indestructible.

IT'S the combination of low brazing temperatures, free-flowing action and diffusion into metal surfaces that makes SIL-FOS and EASY-FLO joints so strong and tough.

SIL-FOS, flowing at 1300° F, and EASY-FLO at 1175° F, penetrate instantly to every part of a joint and "dig in" to make bonds as strong as the metals themselves.

It's the *silver* in SIL-FOS and EASY-FLO that gives them their free-flowing qualities and ability to penetrate and bond so thoroughly.

The *low working temperatures* add to their brazing speed and economy by savings in time and gases—and they also guard against damage to physical properties.

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The program for the balance of the year, which follows, was arranged by the Program Committee consisting of R. H. Newton, chairman, Lincoln Electric Company, and J. E. Williams, The Linde Air Products Company, and will bring to the Section meetings men who are recognized as authorities in their respective fields:

November 14th—"Welding Machine Tool Structures," by L. F. Nenninger, Chief Engineer, Cincinnati Milling Machine Co., Cincinnati, O.

December 12th—"Cutting Process as Applied to Welding Fabrication," by Robert F. Flood, Process Service Engineer," Central Division, The Linde Air Products Co., Chicago, Ill.

January 16th—"Fabrication of Monel and Nickel Alloy Steels," by F. P. Huston, Technical Service. Development and Research Division, The International Nickel Company, Inc., New York, N. Y.

February 13th—"Arc Welding as Applied to Steel Hulls," by H. T. Pott, President, St. Louis Shipbuilding & Steel Co., St. Louis, Mo.

March 12th—"Distortion Problems," by C. H. Jennings, Chemical & Metallurgical Division, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

April 9th—"Designing for Structural Welding," by F. H. Dill, Assistant to Mechanical Engineer, American Bridge Co., Ambridge, Pa.

May 14th—"Weld Penetration," by John Hruska, Chief Metallurgist, Electro Motive Corporation, LaGrange, Ill.

OKLAHOMA CITY

The regular monthly meetings of the Oklahoma City section started Friday evening October 6th, with a dinner meeting at the Biltmore Hotel. Mr. H. L. "Duke" Wiley, Chairman of the Tulsa section of A. W. S. and welding supervisor for Mid-Continent Petroleum Corporation gave an address on the "Three E's of Welding," Engineering, Education and Enforcement. Mr. Wiley who is well qualified to speak on these subjects gave a very interesting talk. At the conclusion of his talk Mr. Wiley introduced Mr. Thames, his welding foreman, at the Mid-Continent Refinery, Tulsa. Mr. Thames told of the origin of "The First Fusion Forum" an organization of some 15 welders and others interested who meet weekly for the discussion and improvement of their work as welders.

Mr. Ralph L. Feagles, coffee speaker, started off with a discussion of the current topics of the day but was interrupted by a radio broadcast of the President of the United States who in addition to his usual remarks regarding the government made special reference concerning engineers and members of the AMERICAN WELDING SOCIETY. The broadcast proved that Mr. Feagles has been giving careful attention to the President's talks and can imitate him perfectly.

A motion picture "A Story in Steel" was shown during the recess between the dinner and the main address.

As a special attraction to get members and guests out for dinner on time, the members drew for an attendance prize shortly after all were seated for dinner.

There were 24 in attendance at the dinner. This attendence was increased to 43 tor the picture and address following the meeting. Several new memberships were obtained at the end of the meeting.

PEORIA

The Peoria section is very well started on its combination of regular meetings and educational series of meetings scheduled for this fall.

Mr. K. L. Hansen, Consulting Engineer for Harnischfeger Corporation, Milwaukee, Wisconsin, opened the season with an illustrated lecture entitled "An Outline of Welding Processes and Equipment." Mr. Hansen summarized and explained each of the common welding processes and illustrated each with pictures which made the application remarkably easy to understand.

"The Oxyacetylene Process in Modern Industry" was described and discussed September 20th by Mr. W. B. Browning, Peoria Service Engineer from the Linde Air Products Company, Chicago, Ill. Mr. Browning's lecture was well attended and unanimously well received.

On October 4th, the "Cost of Arc-Welding was presented by Mr. W. M. Jardine, owner and manager of the Western Welding and Boiler Repair Company, Chicago, Ill. Mr Jardine included in his lecture many points which explained building codes as they effect the welding contractor.

On October 18th, the "Welding of Copper and Copper Base Alloys" was described by an illustrated lecture by Mr. I. T. Hook, Research Engineer for the American Brass Company, Ansonia, Conn., and also Special Lecturer for Yale University on the strength of materials.

The Educational Program of the Peoria Section is as follows:

November 15th—"Inspection of Welds," by W. D. Halsey, Asst. Chief Engr., Boiler Div., Hartford Steam Boiler Insp. & Ins. Co.

November 29th—"Arc-Welded Construction and the Problem of Distortion."

December 6th—"The Unionmelt Welding Process, a Revolutionary Electric Welding Process," by R. F. Flood, Div. Engr., Process Service, The Linde Air Products Co.

December 20th—"Welding of Aluminum," by G. O. Hoglund, Welding Engineer, The Aluminum Company of America.

The above meetings will be held at 7:30 P. M. at the Central Illinois Light Company Auditorium, 310 South Jefferson Street, Peoria, Illinois.

A short technical moving picture will be shown before the lecture and discussion period begins. Admission to all members free. To non-members a charge of 50¢ per meeting, which charge may apply on the payment of membership dues at any time during the season.

The regular monthly meetings are as follows:

January 10, 1940—Dinner Meeting—Entertainment, Business Session, Informal "Mixer."

February 7, 1940—"Welding of Pressure Vessels," by A. J. Moses, General Manager, Hedges-Walsh-Weidner Division of Combustion Engineering Co.

March 13, 1940—"Arc-Welding—Its Progress and Applications in Foreign Countries," by Charles H. Jennings, Research Engr., Westinghouse Elec. & Mfg. Co.

April 3, 1940—"Arc-Welding Applied to Railroads," by R. P. Winton, Welding Engineer, Norfolk and Western Railway Company.

May 7, 1940—"Arc-Welding Applied to Shipbuilding," by L. B. Olson, Welding Superintendent, Manitowoc Shipbuilding Co.

All five of the above meetings will be held at 7:30 P. M. in the Central Illinois Light Co. Auditorium, 310 South Jefferson Street, Peoria.

PHILADELPHIA

A schedule of meetings for the 1939-1940 season of the Philadelphia Section is given in the October Section Activities.

PITTSBURGH

The next regular meeting of the Pittsburgh Section will be held November 15th in the Mellon Institute of Industrial Research, Oakland, Pittsburgh, Pa., at which time the following will be presented.

Speaker: George F. Wolfe, Chairman of Welding Committee, Engineering Works Division, Dravo Corporation, Pittsburgh, Pa. Subject: "The Modernization of a Structural Shop for Welding." This paper covers the changes made in relocation of equipment in the Structural Shop at Neville Island as well as the alteration of old equipment to adapt it to welding production and also the procurement of new equipment more suitable for fabrication in connection with welding.

Speaker: C. Perry Streithof, Structural Engineer, Engineering Works Division, Dravo Corporation, Pittsburgh, Pa. Subject: "Welded Cranes and Hoists." This paper will deal with all-welded gantry cranes, particularly featuring a very recent installation of two large screw luffing full revolving cranes in one of the large eastern shipyards. Some attention will also be given to all-welded hoists and other equipment used in connection with cranes.

The above papers will be illustrated with slides.

PUGET SOUND

The first fall meeting of the Puget Sound Section was held at the Engineers' Club September 18th. The principal speaker was W. J. Smith, Chief Inspector, Hartford Steam Boiler Inspection and Insurance Company, who gave a discourse on the A. S. M. E. Code applied to welding problems.

The first major activity of the Section was successfully executed with a field trip to Coulee Dam for the purpose of witnessing the heavy welding operation on penstocks. Thirty people attended this trip.

ROCHESTER

The October meeting of the Rochester Section was held on the 5th at Todd Union, University of Rochester, River Campus. Mr. G. O. Hoglund, Welding Engineer, Aluminum Company of America, spoke on the subject "Aluminum Welding."

ST. LOUIS

An exceptionally fine talk by the Engineers of the Upper Mississippi River Division of the Corps of Engineers, U. S. Army, was given at the October 13th meeting of the St. Louis Section. Mr. Howard E. Boath, Senior Engineer, began with the history of the 26 locks and dams and told of the change from "Rivet-mindedness" to "Welding Consciousness." Mr. Charles F. MacNish, Civil Engineer, ably illustrated in detail what is meant by "Designed for Welding" and "Procedure Control" on an 80 ft. wide by 30 ft. high Tainter Gate for Dam 24. The members present got a basic course on welding design and control in a practical demonstration and saw why these men received one of the major awards in the Lincoln Arc Welding Foundation prize contest.

SAN FRANCISCO

The first fall meeting of the San Francisco Section was held at the Athens Athletic Club in Oakland. There were forty members and guests present. Chairman T. R. Rooney announced the appointment of Mr. H. E. Constaz of the Midwest Piping & Supply Company as Chairman of the Membership Committee. He also announced Mr. Fred Steckle as Chairman of the Program Committee.

A report on the finances was rendered by Mr. H. W. Saunders, Treasurer.

Three subjects for meetings were chosen as of most interest at this time. They were: Welded Ship Design; Pressure Vessel Design; Welded Fabrication and Construction of Homes.

Mr. Walter B. Graham, Factory Representative of the Wilson Welder & Metals Co., addressed the meeting on "The Practical Side of Manufacturing Electric Welding Machines." Mr. Graham's discussion was well received and considerable time following his talk was devoted to answering different questions.

SAN JOAQUIN VALLEY

The first regular meeting of this Section for 1939–1940 season was held at the Hotel Padre, Bakersfield, Calif., September 29th.

Due to an increasing press of business, Mr. James Bridges tendered his resignation as Secretary-Treasurer. Mr. A. W. Sherer, of the Baash-Ross Tool Company was appointed his successor.

Mr. Walter C. Main, Resident Engineer of the Youngstown Sheet and Tube Co., Los Angeles, presented his paper "Welding Oilfield Casing." This paper was of great interest to the members and their guests as it is a matter with which they come in almost daily contact.

WICHITA

The October meeting of the Wichita Section was held on the 6th at Wolf Cafeteria Banquet Room.

Mr. Darrel Davis, Chief Engineer, Spencer Trailer Company, Augusta, Kansas, presented an interesting talk on the subject of "Welding and Design in Modern Trailer Construction."

The second speaker was Mr. J. A. McCullough, Federal Instructor, Department of Industrial Education, Wichita, whose subject was on "Past, Present and Future of Aircraft Welding." The subject was very timely in that the airplane manufacturing plants in that locality are showing decided increase in activities.

The members and guests were also shown a movie on the fabrication of steel which film was furnished by the Taylor-Winfield Company. There were 36 at the meeting.

YOUNGSTOWN

At a meeting of the Youngstown Section held September 15th at Ohio Edison Auditorium, the following were elected officers for 1939–1940:

Chairman—E. W. Tross
Vice Chairman—J. J. Murray
Secretary-Treasurer—C. R. Riggle.

ANNUAL MEETING COMMITTEES

(Continued from page 729)

O. L. Howland, Chairman, Local Committee on Exhibits; W. C. Pearson, R. L. Kohlbry, I. J. Eales.

Committee on Technical Sessions: E. V. David, Chairman; E. Vom Steeg, Vice-Chairman; W. Spraragen, Secretary; L. S. McPhee, Chairman Local Committee. Supervisors—F. Boley, P. Burns, F. H. Carpenter, H. M. Downing, J. Franzen, W. B. Horton, R. L. Kohlbry, K. Setterblade, W. B. Sharav, M. H. Wigton.

Publicity Committee: M. L. Smith, Chairman; L. P. Aurbach, A. F. Davis, F. G. Flocke, R. L. Gibson, E. Logelin, R. S. Kenrick, M. E. Smith, Geo. Sykes, J. H. Thomson, G. Van Alstyne, F. T. Van Syckel.

Local Committee on Finance: M. S. Hendricks, Treasurer, Chicago Section; H. C. Boardman, A. M. Candy, G. E. Tenney, C. D. Young.

Committee on Inspection Trip: G. E. Tenney, Chairman; E. Kuehn, Vice-Chairman; T. D. Brooke, M. Brown, F. H. Carpenter, H. M. Downing, C. Druetzler, S. P. Everhard, J. Horlock, A. Heseltine, J. Hruska, T. M. Jones, C. J. McGregor, C. W. McKee, G. Palm, E. V. Rippingill, J. W. Shields, Jack Willot.

Entertainment Committee: C. D. Young, Chairman; Clyde Bassler, Paul Burns, F. L. Damarin, I. J. Eales, T. Gallagher, M. S. Hendricks, John Hruska, R. L. Kohlbry, R. E. McFarland, H. T. McKay, R. W. Sternke.

LADIES ENTERTAINMENT

The ladies' entertainment provided through the courtesy of the Chicago Section was enjoyed by all of those present. Inasmuch as this program has not appeared in the JOURNAL, it is being reproduced below.

Sunday, October 22nd.

5:00 P.M.–7:00 P.M.: President's Reception, Tower Room, Stevens Hotel.

Monday, October 23rd

12:30 P.M.: "Get-together Luncheon."

*1:00 P.M.: Empire Room, Palmer House, followed by an automobile tour of Chicago's famous North Side, returning to Stevens Hotel at approximately 4:30 P.M.–5:00 P.M.

Tuesday, October 24th

*1:30 P.M.: Leave Stevens Hotel for an Inspection Tour and Automobile ride through the famous South Side, stopping for visits at the Rockefeller Chapel, the University of Chicago, the Rosenwald Museum of Science & Industry and the Oriental Institute.

Wednesday, October 25th

9:45 A.M.: Leave Stevens Hotel for a visit to Board of Trade.

11:30 A.M.: "Brunch" at Chicago Woman's Club.

*1:30 P.M.: Leave Stevens Hotel for a visit to Field Museum of Natural History, Shedd Aquarium, Art Institute and Adler Planetarium.

Thursday, October 26th

*Noon: Luncheon and Style Show in Wedgewood Room, Marshall Field & Company, followed by an inspection of the store.

7:00 P.M.: Annual Dinner Dance. Boulevard Room, Stevens Hotel.

Friday, October 27th

Visits to Merchandise Mart, Tribune Building, Radio Broadcasting, Chicago Historical Society, Brookfield Zoo, Municipal Airport, Stockyards or similar points of interest.

A registration fee of $3.00 per person charged for items with an asterisk.

Ladies' Committee: Mrs. H. C. Boardman, Chairman; Mrs. A. M. Candy, Mrs. O. L. Howland, Mrs. R. E. McFarland, Mrs. M. S. Hendricks, Mrs. R. S. Kenrick, Mrs. L. C. Monroe, Mrs. C. D. Young.

All the ladies who attended these sessions were unanimous in their praise of the committee in charge of arrangements.

A. W. S. BOOTH

One of the attractive features of the exhibit was the A. W. S. Booth C-121. Mr. R. S. Kenrick (Editor of *Welding Engineer*) was in charge and some member of the committee was always in attendance to welcome anyone and to answer questions. The committee in charge of this booth was: R. S. Kenrick, Chairman; F. W. Boley, R. L. Kohlbry, F. A. Mann, L. W Oday, W. A. Pearson.

ROEBLING OFFICE

The John A. Roebling's Sons Company of Trenton, New Jersey, manufacturers of wire and wire rope, insulated wire and cables and wire cloth and netting, announces the removal of its New York City offices on November 1, 1939, from 107 Liberty Street to the twentieth floor of 19 Rector Street.

F. T. LLEWELLYN MADE HONORARY MEMBER

Mr. F. T. Llewellyn who recently retired as Research Engineer, Department of Research and Technology of the United States Steel Corporation, was made an Honorary Member on the 15th day of June 1939. This award was made in connection with his work in the development of engineering data for use in the design of welded structures which has assisted in the general acceptance of welding as a means of fabricating structural steel in building construction. The certificate will be formally presented to Mr. Llewellyn on the evening of December 20th at a joint meeting of the New York Section of the AMERICAN WELDING SOCIETY and the American Society of Civil Engineers. Everyone who can do so is urged to attend and by his presence add to the effectiveness of the occasion.

REINFORCED WELDING HELMET

A new light-proof seamless welding helmet, designated No. 406, having reinforced side ribs has just been announced by the Chicago Eye Shield Company, 2300 Warren Blvd., Chicago, Illinois.

Made in one piece from vulcanized fiber, and without rivets, this new welding helmet has been designed with two reinforcing ribs on each side. The ribs, moulded in the fiber, strengthen the helmet, add to its rigidity, and prevent warping. Another feature listed for this helmet is a newly designed lens holder, so made that the entire lens holding unit may be removed by loosening two screws. The cover glass or welding lens can be quickly removed or replaced without the use of tools. The head gear can be adjusted to required size and once adjusted, it will remain in position until changed. Wearing comfort and even weight distribution is assured.

List of New Members

Sept. 1, 1939 to Sept. 30, 1939

BIRMINGHAM

Davidson, R. W. (C), Ingalls Iron Wks. Co., Birmingham, Ala.

BOSTON

Konetchy, Edward V. (B), Walworth Co., 1st & O St., So. Boston, Mass.

CANADA

Beckett, George H. (B), Box 212, Mission, B. C., Canada.

CHICAGO

Morgan, T. W. (C), 1426 E. 65th St., Chicago, Ill.

CINCINNATI

Disereus, Ralph S. (C), Cincinnati Shoper Co., Hopple & Garrard, Cincinnati, Ohio.
Winkelman, H. E. (C), National Cylinder Gas Co., 4620 Este Ave., Cincinnati, Ohio.

CLEVELAND

Davis, Walter E. (C), The Cleveland Railway Co., 600 Midland Bldg., Cleveland, Ohio.

COLUMBUS

Filimon, Victor (F), 159 E. Lane, Columbus, Ohio.

HAWAII

Chalmers, Robert F. (C), P. O. Box 45, Paauhau, Hawaii, T. H.

KANSAS CITY

Moore, J. R. (B), The Capitol Iron Wks. Co., 7th & Adams St., Topeka, Kans.
Swaffar, Howard (D), 4200 E. 9th St., Kansas City Mo.

MARYLAND

Broski, Chester M. (D), 327 So. Cornwall St., Baltimore, Md.

NEW YORK

Bleecker, Kenneth B. (B), Page Steel & Wire Div. of American Chain & Cable Co., 230 Park Ave., New York, N. Y.
Galloway, T. R. (B), Consolidated Edison Co., 4 Irving Place, Rm. 1500A, New York, N. Y.
Haller, Alfred P. (C), Haller Welding School, 522 Bergen St., Brooklyn, N. Y.
Lavoy, Louis (C), Louis Lavoy, Inc., Knapp & Harkness Ave., Brooklyn, N. Y.
Loiselle, Edward (D), 111 East 127th St., New York, N. Y.

NORTHWEST

Kvasnicka, Wesley J. (C), 4822—30th Ave. So., Minneapolis, Minn.

OKLAHOMA CITY

Frost, Sargent E. (F), Aggie Lodge, Stillwater, Okla.
James, Louis (F), 524 Knoblock, Stillwater, Okla.
Miser, Vernon (F), Oklahoma A. & M. College, Stillwater, Okla.
Schultz, Herold (F), 124 West St., Stillwater, Okla.

PHILADELPHIA

Romanik, Mike (D), 105½ Whitall Ave., Millville, N. J.

QUAD CITIES

Rigler, G. W. (D), Prophetstown, Ill.

SAN FRANCISCO

Durand, William F. (B), Stanford University San Mateo Calif.
Phillips, Horace P. (C), 400 Paul Ave., San Francisco, Calif.

SOUTH TEXAS

Lincoln, P. M. (C), Reed Roller Bit Co., Houston, Texas.
McCarthy, H. P. (C), Rt. 11, Box 138, Houston, Texas.
Roberts, E. T. (C), 8030 Easton St., Houston, Texas.
Welch, H. L. (D), 2512 White Oak Dr., Houston, Texas.

TULSA

Smith, C. F. (D), 430 So. 39th, Tulsa, Okla.

WASHINGTON, D. C.

Chappelear, J. A. (C), J. A. Chappelear & Son, Mills Building, Washington, D. C.
Frankland, J. M. (C), U. S. Navy Yard, Washington, D. C.
Hodges, E. C. (B), 1713 K St., N.W., Washington, D. C.
Ladd, Robert N. (C), 30 Carroll Ave., Takoma Pk., Md.
Perry, Charles F. (C), Bureau Marine Insp. & Nav., 1069-A Commerce Bldg., Washington, D. C.
Ritter, Julius C. (C), Bureau of Const. & Repair, U. S. Navy Dept., Washington, D. C.

NOT IN SECTIONS

Berry, Elmo (D), c/o Roscoe Berry, Louisa, Ky.
Cole, Amos G. (C), Standard Steel Works Co., Burnham, Pa.
Hill, Gale E. (D), 35 Railroad St., Keene, New Hampshire.
Maroni, Angel A. (B), Maroni Hermanos & Cia., 24 De Noviembre No. 1763–69, Buenos Aires, Argentina.
Walker, George H. (B), American Locomotive Co., 100 Orchard St., Auburn, N. Y.

(*Continued from page 725*)

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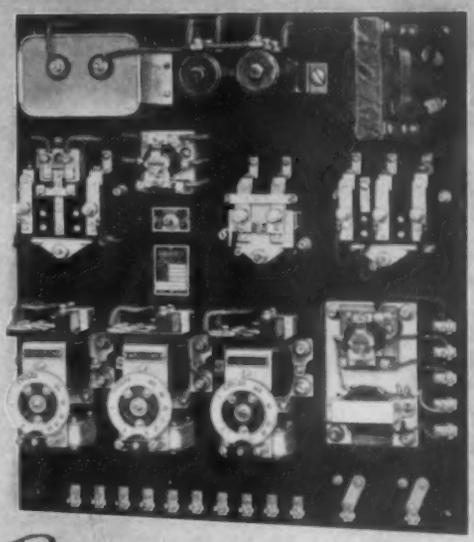
New SQUARE D

SEQUENCE WELDER CONTROL



Positively INTERLOCKS

AIR PRESSURE with CURRENT FLOW!

● The Square D sequence panel is used with an air-operated welding machine to automatically perform the following duties:

1. Controls the solenoid air valve to automatically apply pressure to the work.
2. After a predetermined interval to allow the pressure to build up, it energizes the timer of the current control.
3. When the weld is completed, it determines the period during which the electrodes maintain pressure after the current is cut off.
4. It controls the period when the electrodes are open before the operating cycle is repeated.

For electronic equipment, a protective relay is necessary. This relay is energized from the load side of the power tubes and is specially designed to operate under a wide variation in voltage. This interlocking system prevents the electrodes from opening while any current passes through the electrodes. It also permits independent adjustment of the weld time without changing the other sequence intervals.

Squeeze time, hold time, and *off time,* are separately adjustable to suit the exact requirements of the welding operation. Faster production and better welds result.

The Square D sequence panel can be added to the control of any air-operated welding machine to give full automatic operation.

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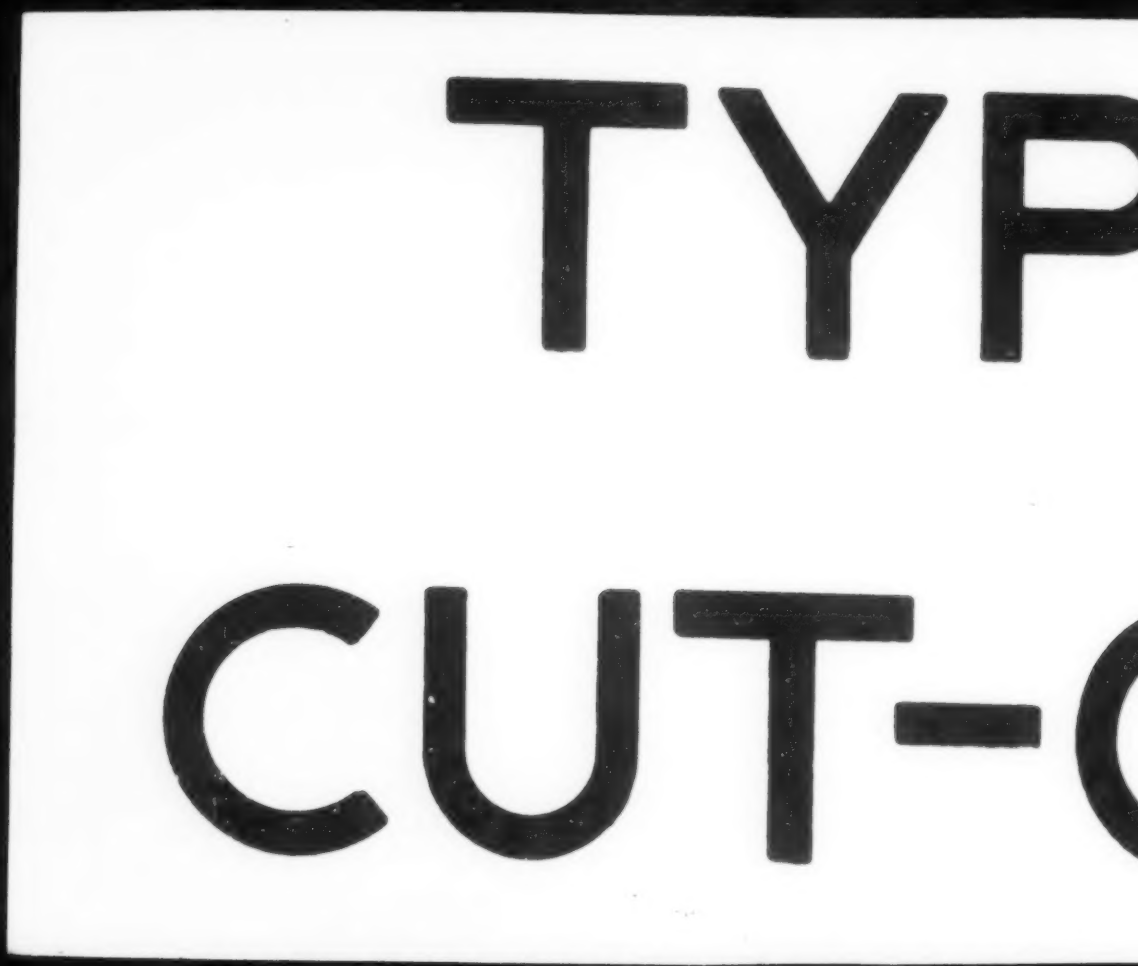
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Yet, with all the economy of Murex welding, there is no slacking off in the quality of work produced. The Murex line includes electrodes that, even when used at extremely high currents, assure X-ray clean deposits and beautifully smooth, neat seams that meet every requirement for strength and ductility.

Let a representative demonstrate the Murex Electrode best suited to your work. At the same time, make the most of his broad experience by asking his help on your difficult problems. Write today. There is no obligation involved.

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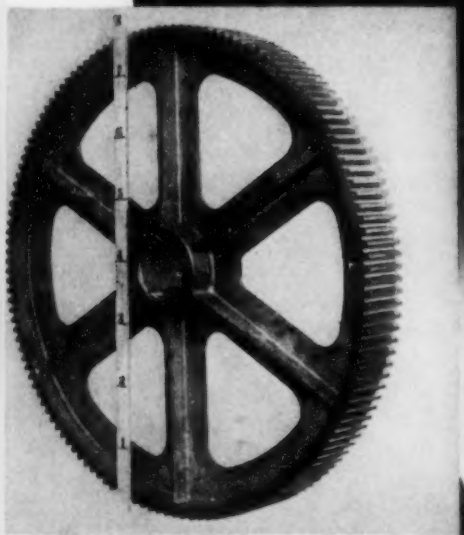
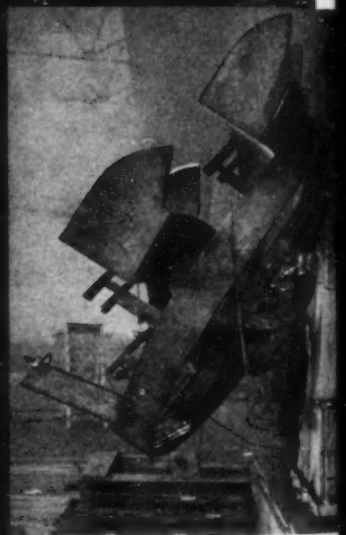


1 High speed deposition of always sound metal saves time and money in producing parts such as this gear. *Photo courtesy Lakeside Bridge & Steel Co., Milwaukee, Wis.*



2 Ample physical properties for welds in equipment are assured by selecting the Electrode for the job. *Photo courtesy Smith Co., York, Pa.*

3 Most welders prefer Murex because slag removes readily and saves cleaning time. *Photo courtesy Ira Bushey & Sons Co., Inc., Brooklyn, N. Y.*

4 Many manufacturers find it easier with Murex to qualify welders for pressure vessel work under code requirements. *Photo courtesy Edge Moor Iron Works, Edge Moor, Del.*

5 Ten cents per pound of deposited metal were saved by Murex on a fabricating job at a large Pennsylvania shop. *Photo courtesy [illegible] Mfg. Co., Denver, Colo.*